THE American JOURNAL OF Surgery

JULY 1956

THURSTON SCOTT WELTON, M.D., EDITOR

Plastic and Reconstructive Surgery

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SIXTY-FIFTH YEAR OF PUBLICATION

JULY 1956

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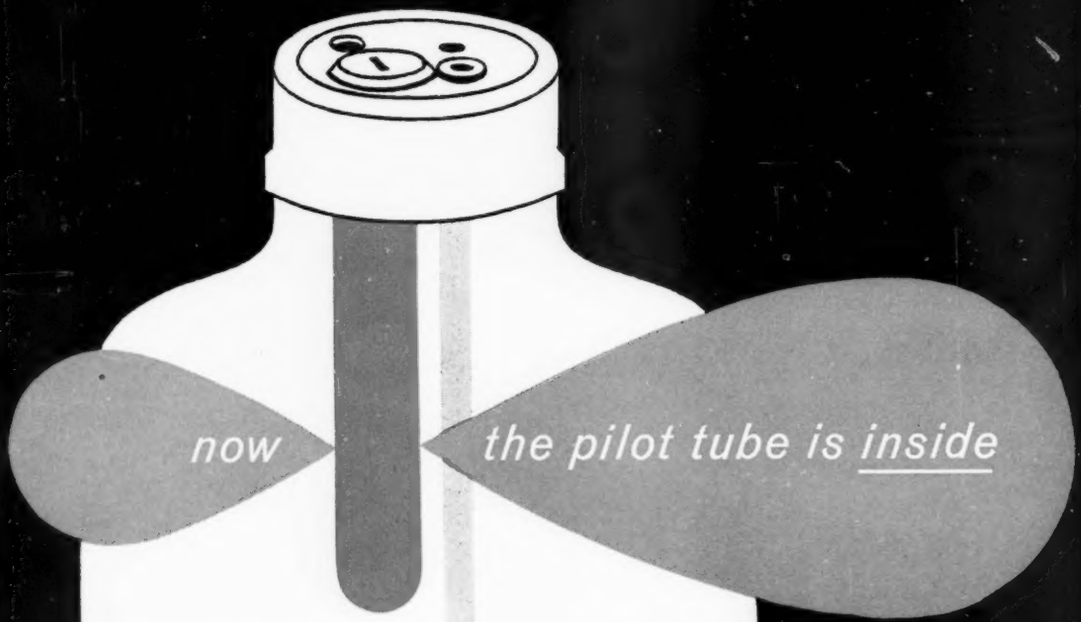

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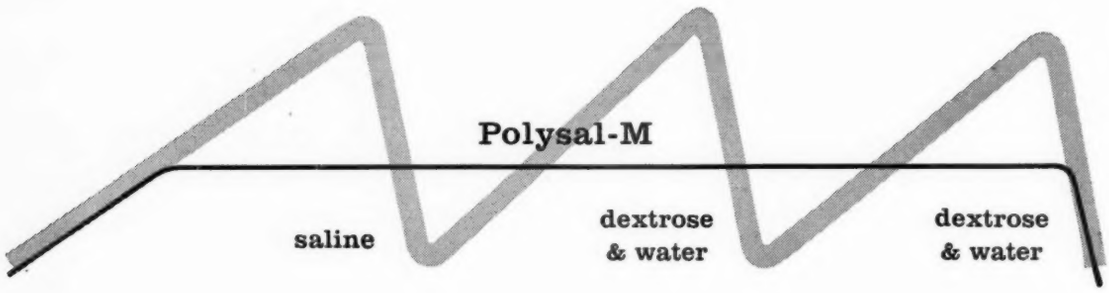

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*Talbot, N. B., Crawford, J. D., and Butler, A. M., "Homeostatic Limits to Safe Parenteral Therapy". New Engl. J. Med., 248, 1100 (1953)

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J. C. Bacala, M.D.

(Abstracted from the Western Journal of Surgery, Obstetrics, and Gynecology, 64:88 (1956)

The author emphasizes the need for dependable chemical control of bleeding and oozing, and reviews the methods that have been tried to attain hemostasis, including the use of vitamin K and bioflavonoids.

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He reviews 1051 cases from the files of St. Anthony Hospital, Louisville, Kentucky, of which 330 were treated with Adrenosem Salicylate. 317 were surgical cases and 13 obstetric-gynecological conditions. The treatment was given for symptomatic relief, and as a clinical recourse for patient safety.

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The author points out that in pregnancy, seepage bleeding occurs more because of capillary permeability, and in spite of increased coagulability. Here, Adrenosem becomes specific for strengthening capillary resistance.

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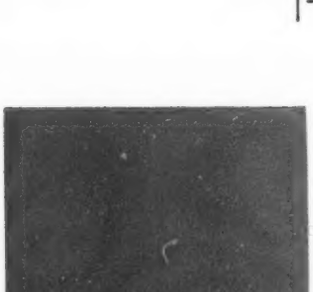

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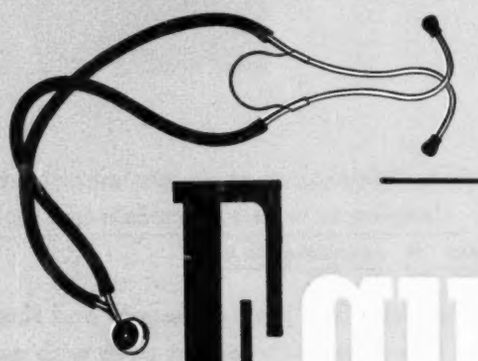

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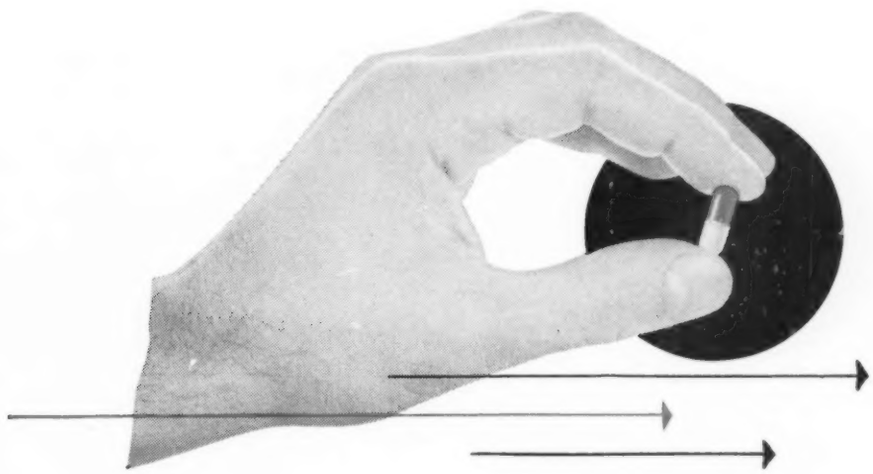

to overcome specific infections that do not respond to any other antibiotics.[1,2,3]

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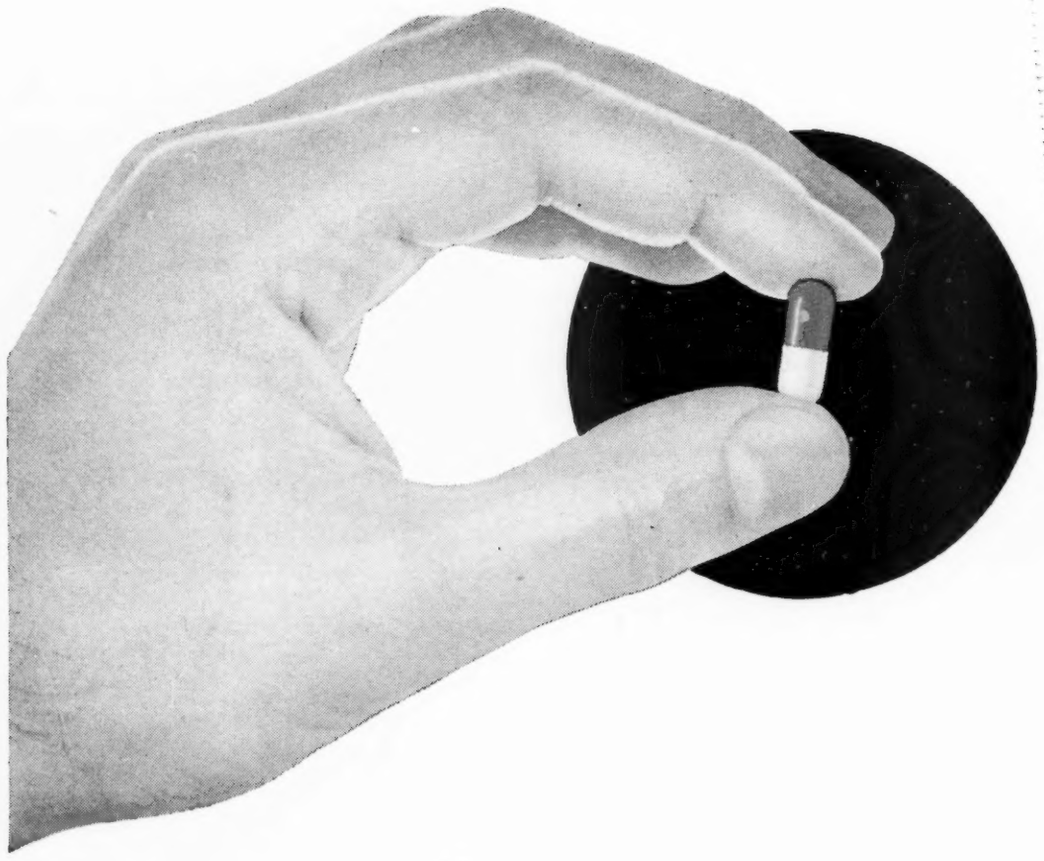

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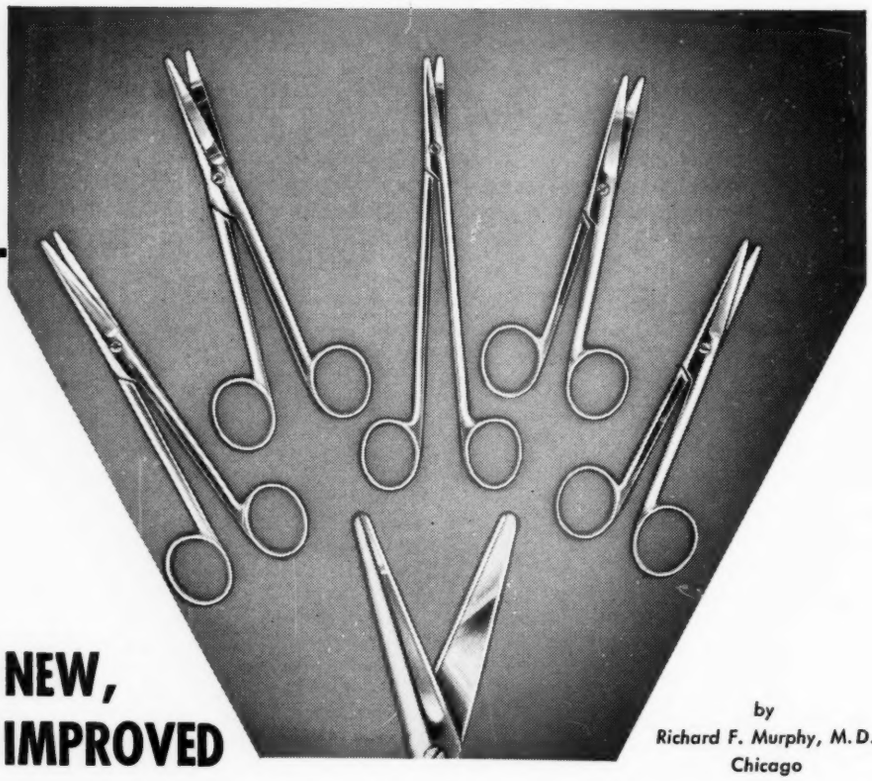

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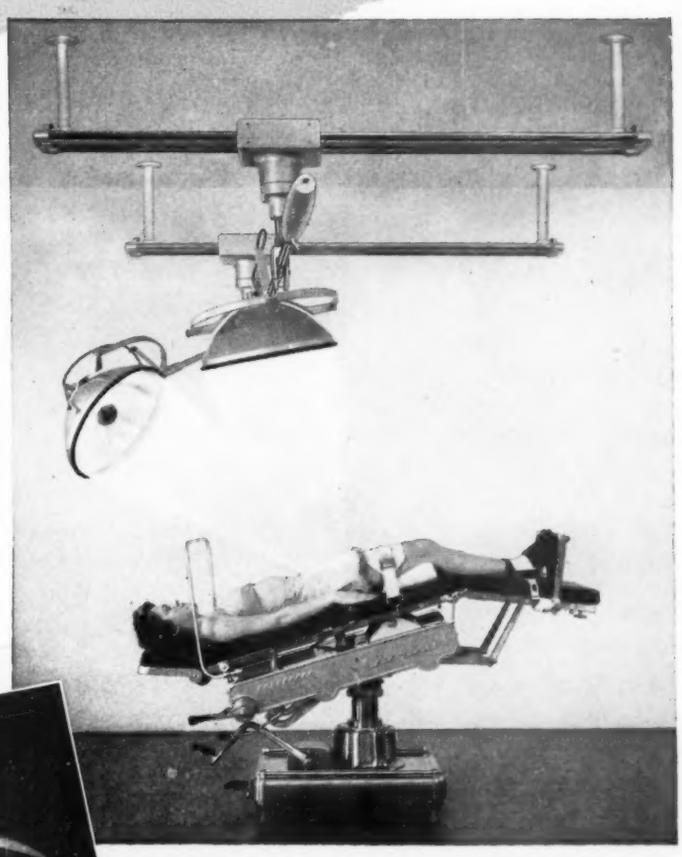

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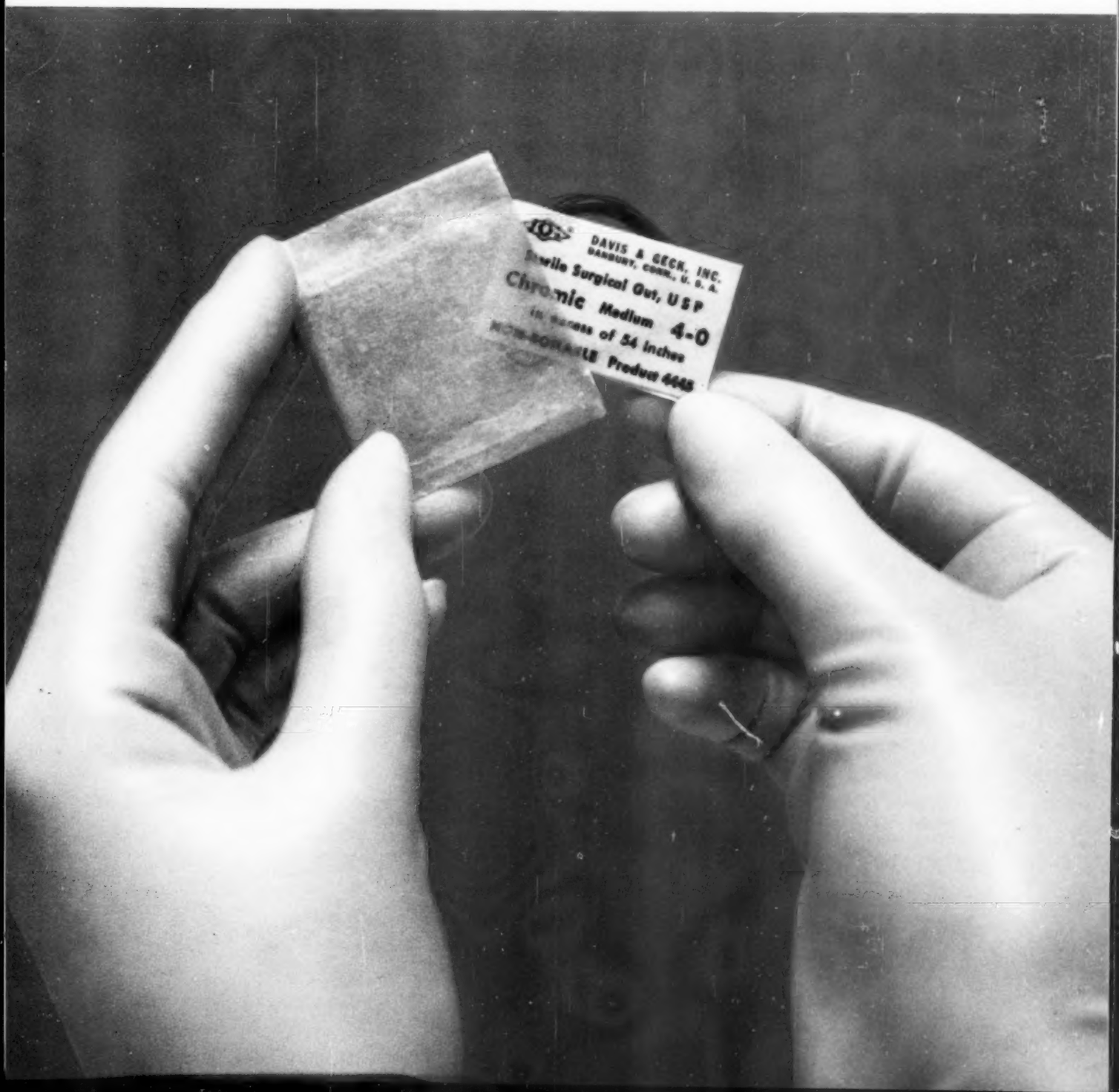

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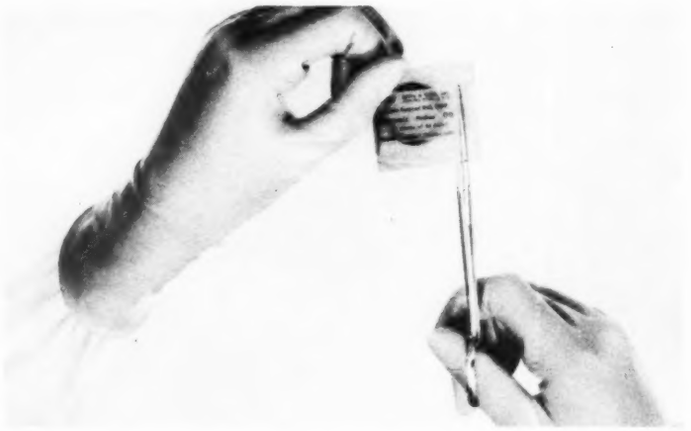
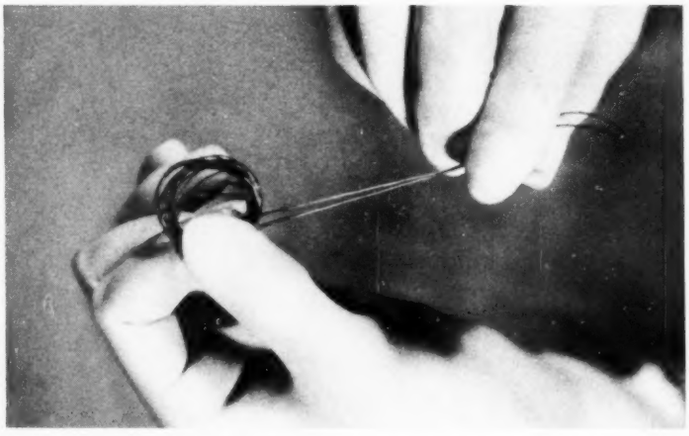


2 *More nurse-power for surgeons!* Suture nurse saves 33⅓% handling time—just one snip of the scissors opens the new D & G SURGILAR envelope. Surgeons report nurses have more time to give for other important duties.

3 *No more shattered tubes!* Suture nurse quickly removes ready-to-use sterile suture, individually wrapped in easy-to-read label. Nurses report they no longer worry about cut gloves, damaged linens and accidental tube breakage.



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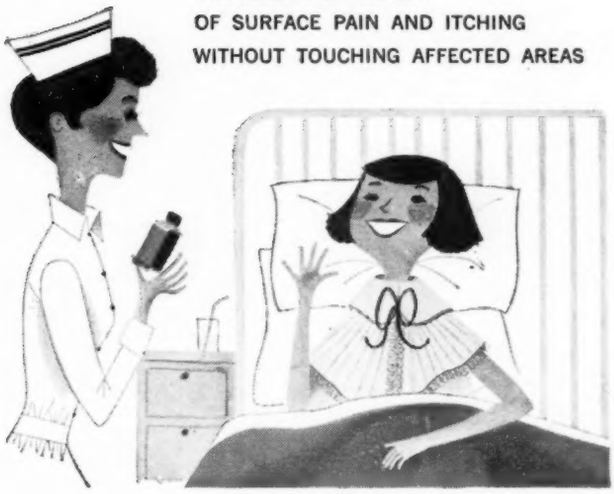

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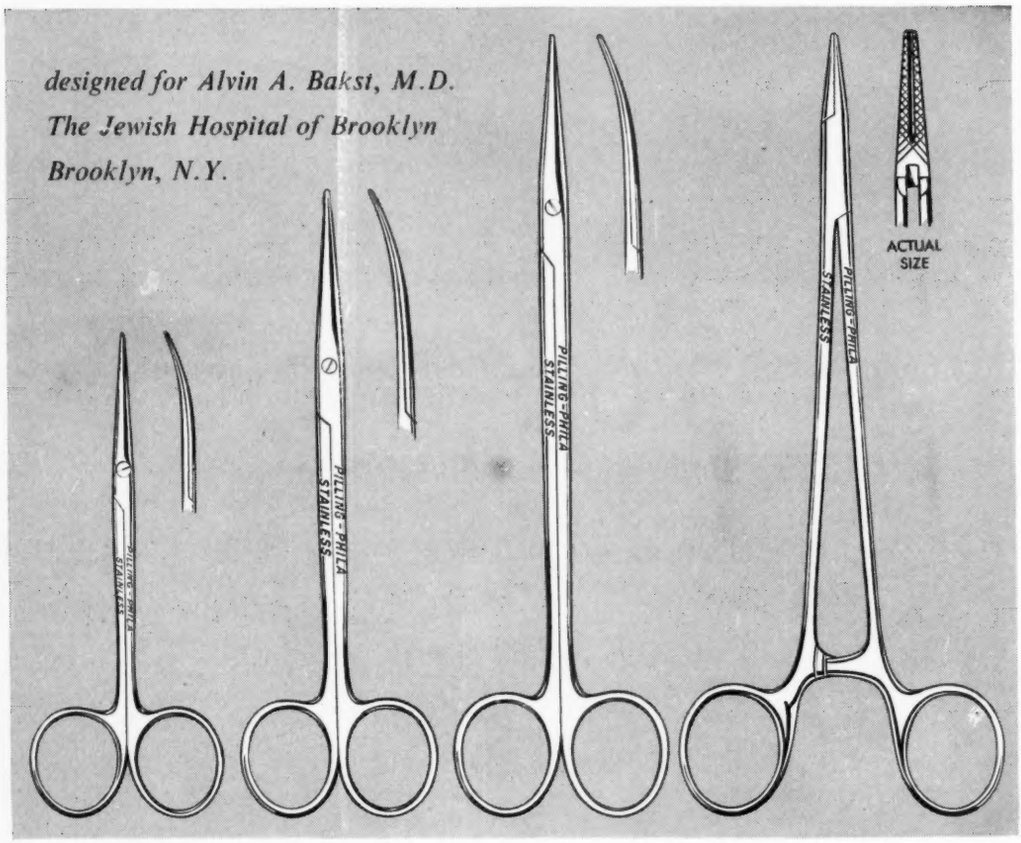

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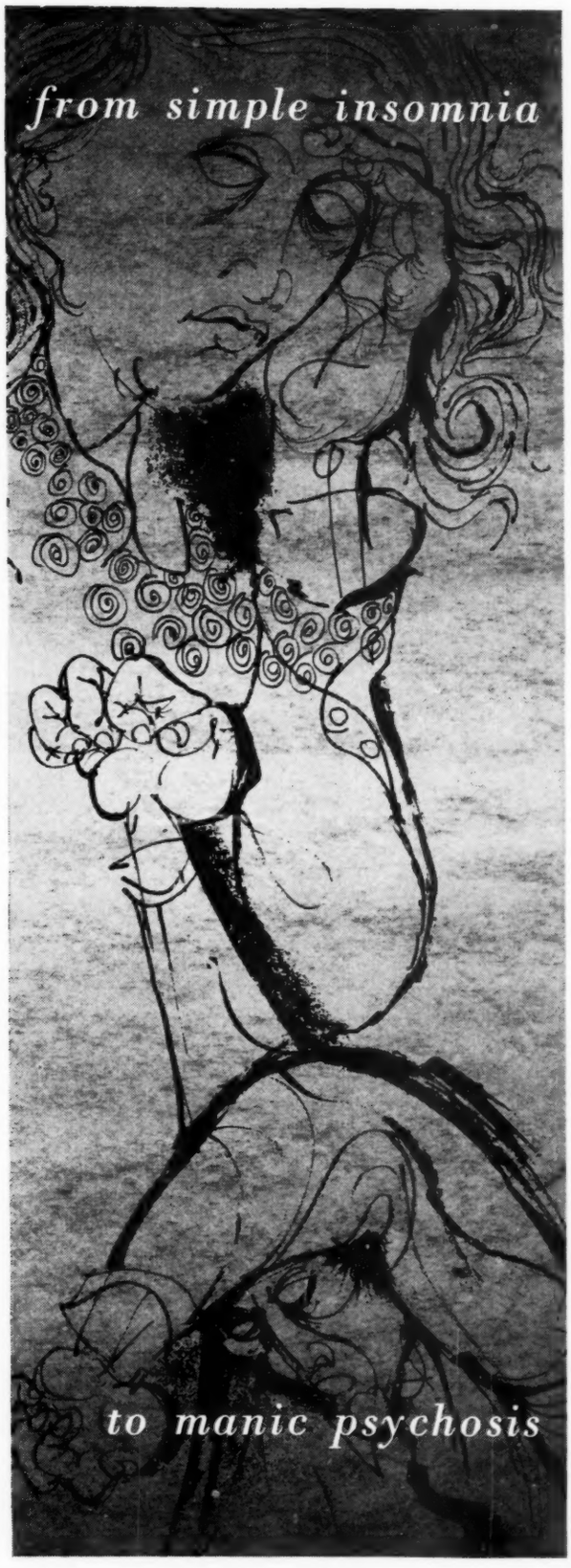

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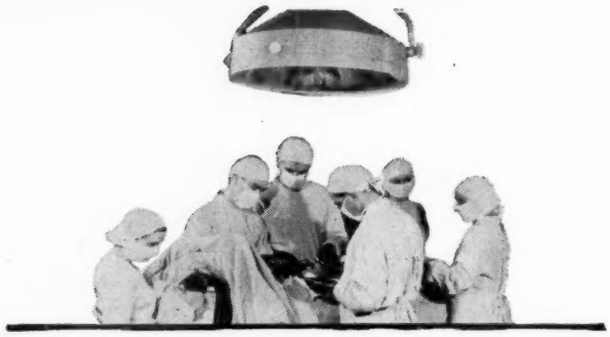

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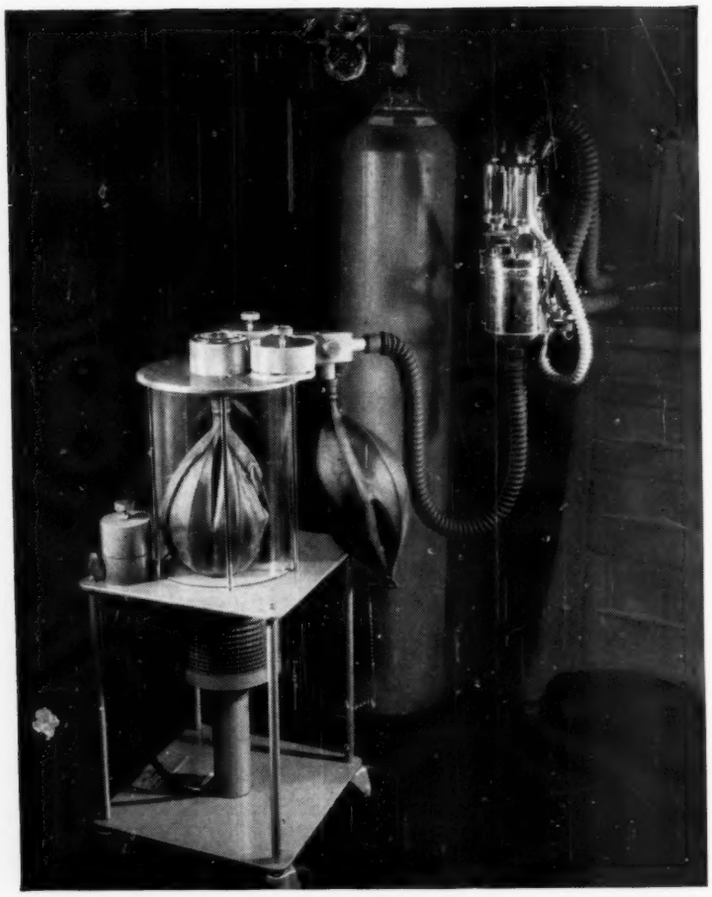

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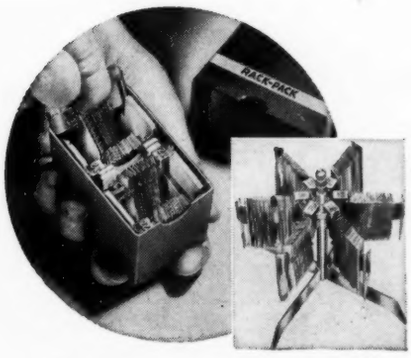

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References: 1. Rhoads, J.E.: Internat. Abstr. Surg. *94*:417, 1952. 2. Mecray, P., Jr.: Am. J. Clin. Nutrition *3*:461, 1955. 3. Cannon, P.R.: J.A.M.A. *135*:1043, 1947. 4. Halpern, S.L., in Nutrition in Infections, Miner, R.W., ed.: Ann. New York Acad. Sc. *63*:147, 1955.

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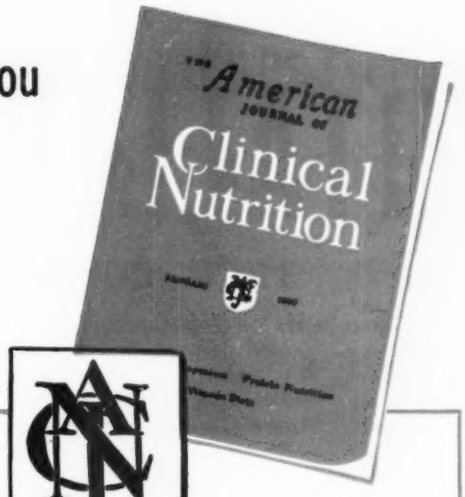

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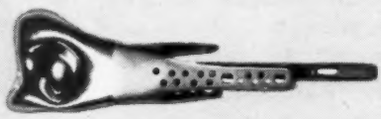

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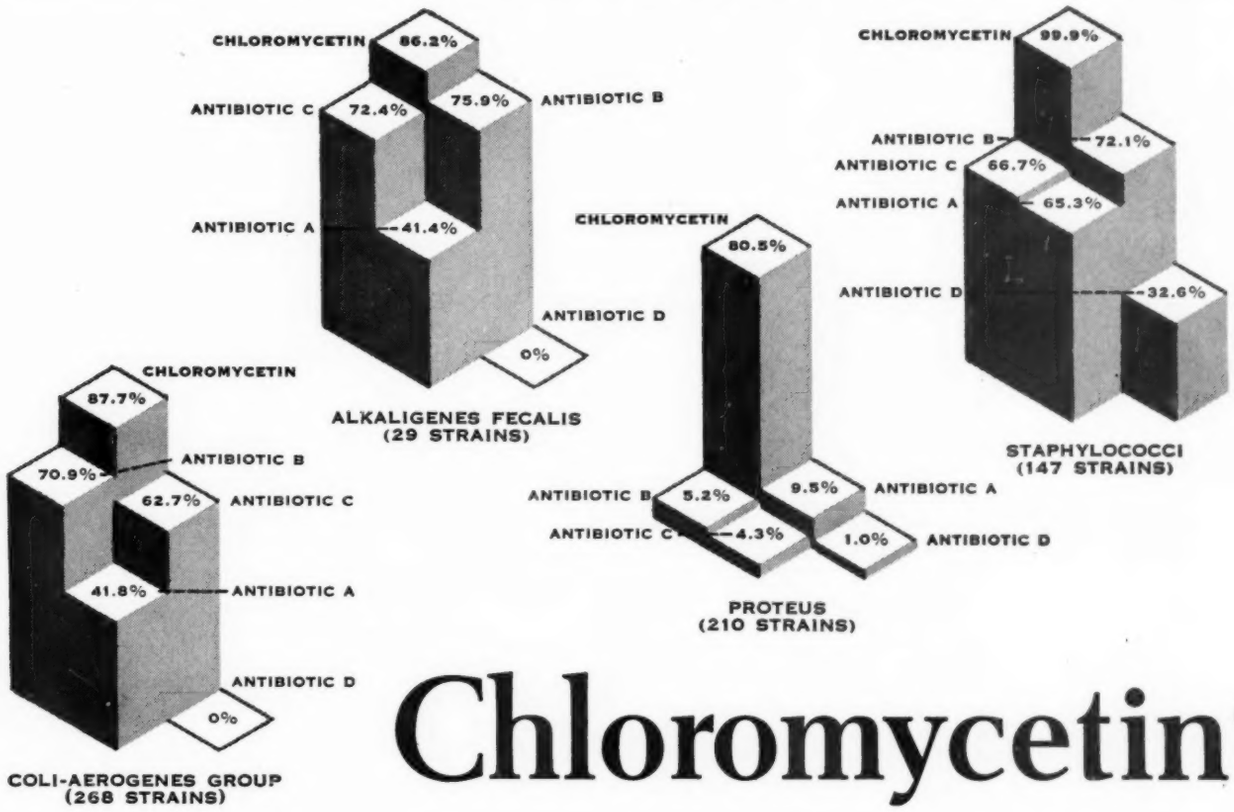
*This graph, based on *in vitro* studies, is adapted from Weil and Stempel.[5] It represents the second and concluding part of data presented in a previous issue. Studies were made at the Bronx Hospital, New York City, an institution representative of the situation in large general hospitals.

SENSITIVITY OF COMMON PATHOGENS TO CHLOROMYCETIN AND FOUR OTHER MAJOR ANTIBIOTIC AGENTS*



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references: (1) Tebrock, H. E., & Young, W. N.: *New York J. Med.* 55:1159, 1955. (2) Bunn, P. A.; Canarile, L., & Eastman, G.: *New York J. Med.* 55:3607, 1955. (3) Perry, R. E., Jr.: *North Carolina M. J.* 16:567, 1955. (4) Horton, B. F., & Knight, V.: *J. Tennessee M. A.* 48:367, 1955. (5) Weil, A. J., & Stempel, B.: *Antibiotic Med.* 1:319, 1955. (6) Altemeier, W. A.; Culbertson, W. R.; Sherman, R.; Cole, W.; Elstun, W., & Fultz, C. T.: *J.A.M.A.* 157:305, 1955. (7) Jones, C. P.; Carter, B.; Thomas, W. L., & Creadick, R. N.: *Obst. & Gynec.* 5:365, 1955. (8) Austrian, R.: *New York J. Med.* 55:2475, 1955. (9) Sanford, J. P.: Favour, C. B., & Mao, F. H.: *J. Lab. & Clin. Med.* 45:540, 1955. (10) Munroe, D. S., & Cockcroft, W. H.: *Canad. M. A. J.* 72:586, 1955. (11) DeVries, J. A., & Pritchard, J. E.: *Canad. M. A. J.* 73:827, 1955.

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4. Turell, R.: New York St. J. M. 50:2282, 1950.

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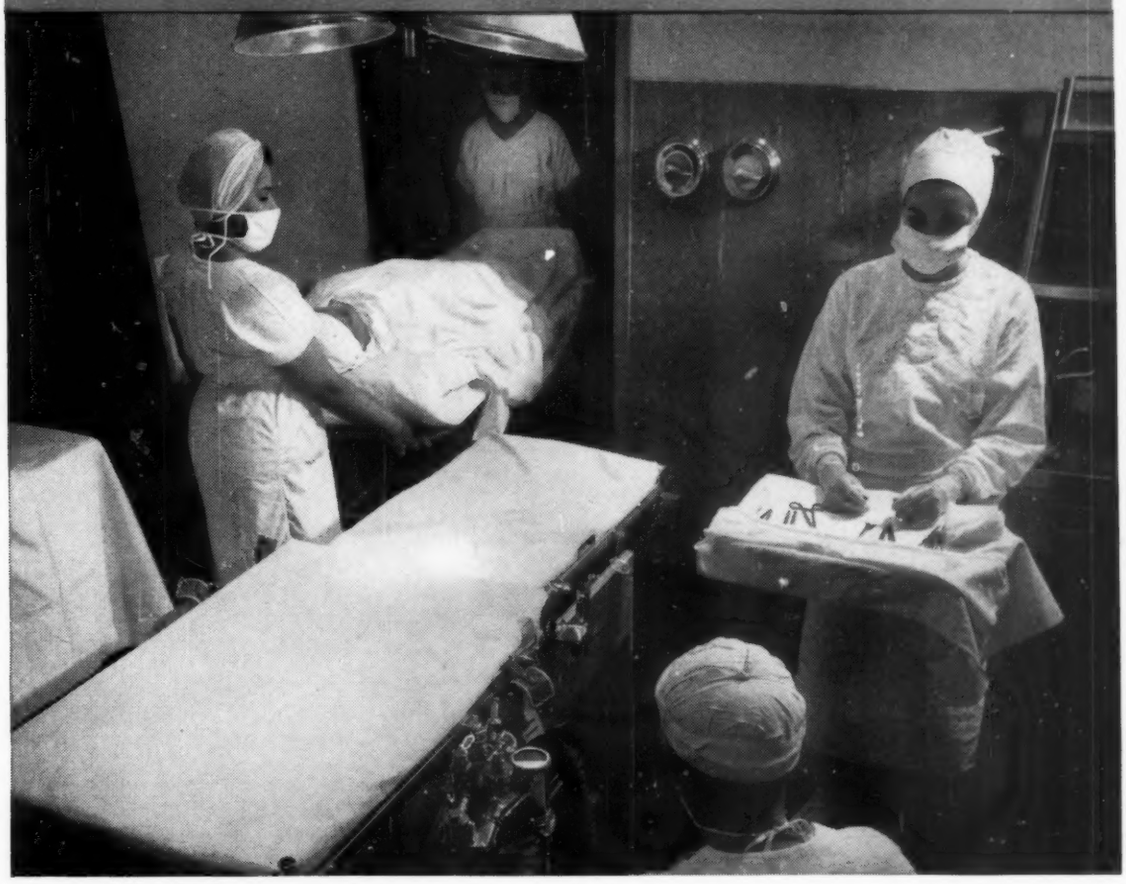

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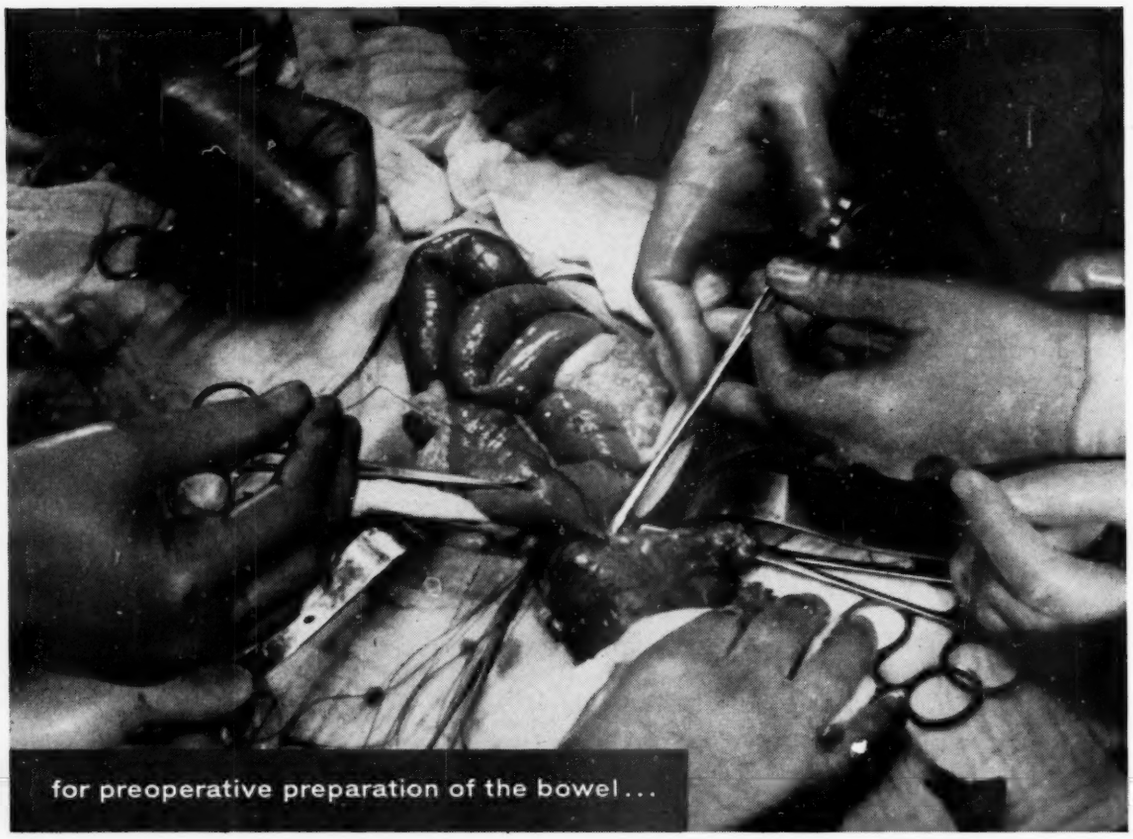

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PLASTIC AND RECONSTRUCTIVE SURGERY

Must We Procrastinate?

DURING the span of a single lifetime scientific progress has produced results which have exceeded the imagination of man. Scientific research has developed that which surpasses the fancy of fiction writers. During this short period history has recorded these facts. Today we not only proudly proclaim the development of the atom bomb but also the first atomic-powered submarine and the first atomic power plant. Accomplishments such as these are so encompassing in their potential power and scientific perfection that the mind of man shudders to consider the remote possibilities which may result.

Twentieth century man envisioned the possibility of flight and within a short period it became a reality. The Wright brothers succeeded in their flight in a "heavier-than-air" craft. In the same period countless examples of such startling progress have been offered: the discovery of radium, the development of x-ray, the creation of the atom bomb, the development of wonder drugs and a host of other discoveries. As a result of this progress, our concepts have been altered; our thinking has been torn asunder as a result of man's attempt to adjust and develop a formula for living which would be adequate for this dizzy pace. The problem has been so encompassing and fraught with so many frustrating demands for adjustment that it is not amazing that many old creeds have been submerged and many queer philosophies have appeared. The wonder is that numerically there have not been more. We sit on the sidelines in breathless anticipation of that which may develop next. We have witnessed the ravages of three recent wars, each growing progressively worse than the other in horror and destructive potential, until finally the apotheosis of all horrible potentials was presented in the destructive power of the atom bomb. As a result of these developments, the mind of man has been disturbed to the point of accepting many of the philosophies offered today. A few years ago these philosophies would have been recognized as deviations from fundamental truths.

Salvation must lie in the perspective which emanates from evaluation that is based upon the acceptance and application of truth. It is as fundamental today as when taught by the lowly Nazarene 2,000 years ago. Its pursuit would go far in aiding mankind to adjust mentally, and it would act as a powerful sedative in restoring tranquility and the peace of mind necessary to abolish fears and delusions.

Just as frontiers have been changed as a result of wars and political parties, and just as philosophies within parties have been drastically altered, so has medicine today been confronted with the same pressures from identical sources. Philosophically, medicine has been subjected to pressures which are as powerful and equally as effective as any of the forces which alter concepts on a national or international level. Unfortunately, many of the forces which subjugate nations to the acceptance of destructive policies lay the same heavy hand upon the shoulders of medicine. Coordinated with these forces are conditions which aid in the destruction of the sound and established good that is found in medicine. This decline parallels that achieved by ruthless politicians in their efforts to effect their selfish

plans by means of the same destructive programs against good government. Not infrequently, retrogressive changes in medicine are instigated by these same ruthless politicians in association with equally ruthless politicians in medicine, who join their efforts to accomplish the same evil end.

It is paradoxic that existing trends in the thinking of large masses of people reflect criticisms of the system of medicine offered the American people today. This system is historically superior to any system of medicine heretofore made available to the world. It is also inconceivable that these groups could logically criticize the progress of the superb medicine of today. An explanation, however, may be found when one realizes that these criticisms represent a familiar brand which has notoriously been offered by ruthless zealots of a political dictatorship type, as a softening-up procedure to enable them to move in and take over in other areas. The pattern is too well known and too familiar not to be significant. One hears that costs are far in excess of that which a patient would like to pay, not presuming to consider that what this really implies is that the critic would like all medical costs to be entirely free in order that he might have more to squander for his own pleasures. The thought is never harbored that it is essential that a majority of the people be honest and responsive in meeting their fixed and accepted obligations if a nation is to be successful and respected. These same critics presume to criticize the cost of medicine while at the same time they squander their own assets for non-essentials and useless expenditures of no real value to themselves or to their families. These examples represent nothing more than attempts to solicit something for nothing. Such is the environmental climate created by the unfettered "give away" political system to which we have been subjected in the last decades. This attitude can even be found in the younger members of our profession, who as a natural consequence of the accelerated pace and false and materialistic goals of the social system that we live in have somehow failed to grasp the fundamental issues at stake. How tragic it is to see the classic ideals of Hippocrates cast aside in exchange for the false rewards of exaggerated monetary remuneration such as is offered by our government institutions, who presume to compete with free medicine. It is easy to see the distorting effect of such pressures upon minds already too occupied with thoughts of hurrying through training "catch as catch can" without stopping to consider the incalculable value and the unredeemable worth of the training being offered which more than counterbalances a low stipend. It is contrary to reason that one would, on the one hand, request free medical care and on the other hand, expect to pay for beer or an automobile or a house; yet there are many who reflect this particular brand of thinking. Associated with this is the criticism frequently heard that doctors are responsible for the high cost of medical care. The fallacy here is failure to consider the numerous costs which present day systems have imposed in these areas. Of great significance are the high cost of hospitalization, nursing care, modern drugs, x-ray therapy, physiotherapy and the application of equipment designed for more and more accurate diagnoses. The physician is blamed for many of these unusual expenses. Actually blame for many of these costs should rest directly at the feet of the critics and can be explained by their demands for more expensive rooms, better service and more nursing care. One large item which is responsible for a great portion of the increase is the mounting cost of labor with shorter hours and lessened production from labor efforts. Labor unions, in their demands for more, better and cheaper medicine, fail to appreciate that their efforts produce a constantly diminishing return along with increasing labor costs. Most critics fail to realize that the great mass of practicing physicians today charge fees which, with few exceptions, show little change during the last twenty years. Compare this with the record of labor's increase during this period along with the numerous increases in basic living costs and taxes which are imposed even on a physician's family. Neither do they consider that physicians are subjected to calls far beyond the implied duty of any other group. Physicians can know no forty-hour week.

One should be constantly alert to the possibility that much of the present day criticism is directed toward tearing down a system of medicine which is so superb in its reflection of progress, lessened mortality and morbidity that the span of life has been materially increased during the past twenty years. The possibility certainly exists that much of this is designed to effect a change which will permit

many ruthless politicians and ambitious lay zealots to gain a foothold in the directing and management of medicine for their own personal gains and ambitions.

We should be ever mindful of the possibilities of occasional members in our own ranks who through weakness and indifference lend themselves to the suggestions and coercions of ambitious politicians. History records pages of this type of sordid reading. These impose upon medicine the responsibility of recognizing that indifference, incompetence and other criticisms of this nature are eligible to be levelled at medicine if one presumes to direct this criticism on the basis of a few isolated examples. These usually emanate from the actions of a relatively small group of individuals. There is nothing illogical in this reasoning, for medicine is made up of a composite group of human beings who reflect the concepts of the average in their actions, outlooks and philosophies. This is a fundamental truth which can be levelled at any group. Medicine as a whole should not be blamed for the actions of a few; yet the burden of acknowledging this fact to the masses lies squarely upon the shoulders of medicine.

Just as in industry, those responsible in medicine should take cognizance of the importance of resurveying its horizons in terms of alterations resulting from scientific advancement, in order that they get their respective houses in order and thus minimize discord and criticism. We in medicine should become equally alert in appraising the lay public of our own shortcomings, for in this way we may correct many of the obvious inadequacies which now exist. In this manner a more favorable and fuller understanding may be established between medicine and those we serve. As a result of such progress much can be accomplished and a far better job of public relations will ensue. It is through these types of pursuits that our most diligent efforts and our best thoughts should be applied. It must be realized that the problem is not hopeless; that it is not too late for correction and that it exists as a challenge. The time has come when it is imperative that we accept all of our responsibilities. We have still a vast majority in medicine who show sincere concern and who will adhere to the same sound fundamental truths which have made medicine in the United States a powerful force for good.

It is a sincere hope that the large representative group in medicine who are concerned and scrupulously honest at all times will continue to bear the grail, symbolic of accurate appraisal and determination to render the best service.

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We are living in a golden age of scientific medicine. Greater progress has been made in the last two decades than in the preceeding 2,000 years, and the end of further miracles is not in sight. Plastic and reconstructive surgery is no exception. This new field is made possible because of many factors, including present day anesthesia and trained anesthesiologists, new and better types of suturing material, the sulfa drugs and antibiotics, blood, plasma, a knowledge of the body fluids, a wealth of new types of surgical instruments, and new surgical technics and refinements of older technics. Still a young specialty, many surgeons are performing plastic and reconstructive operations that only yesterday were considered in a closed, forbidden field. One feels justified in predicting that tomorrow still greater progress will ensue in this field and in medicine generally.

T. S. W.

Changes in Skin Flap of a Constructed Vagina Due to Environment

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THE changes in cells due to environment were strikingly illustrated in one of our patients for whom a vagina had been constructed. Because twenty years had elapsed,

FIG. 1. Vagina constructed from pedicle skin flap. Photograph twenty years later.

the changes may have been more complete than in any other reported case. (Fig. 1.) This article will discuss the alterations observed and will attempt an explanation.

A similar case reported by Whitacre and Alden[1] affords the only detailed observations on this aspect of a rare condition. The incidence of congenital absence of the vagina, or müllerian failure, has been quoted as 1 in 5,000 (Engstadt) and 1 in 4,000 (Bryan et al.[2]) However, Owens[3] found only six cases of 502,081 female admissions to the Charity Hospital, New Orleans, Louisiana, over a thirty-four-year period. Of these admissions, 123,676 were to the gynecologic service where the condition would have been most noteworthy.

In the typical case of aplasia or agenesia of the vagina, the vulva and clitoris are normal. The introitus is covered across by epithelium which is not a diaphragm but is based on solid tissue. A dimple or indentation of this mucosa may be present in varying degree. The uterus is absent or rudimentary. The wolffian components are usually present as normal tubes and ovaries. In addition to pelvic examination via the rectum, examination should include endoscopy, for cases have been reported of the presence of a vagina opening into the urethra.

The first case of vaginal aplasia recorded was that of Realdus Columbus in 1572; Dupuytren first attempted construction of a vagina in 1817. Some of the later efforts were made by: Heppner, 1872, pelvic dissection with insertion of skin flaps; Baldwin,[4] 1907, using a segment of ileum; Frank,[5] 1925, full-thickness grafts and later, 1935, pressure invagination; Kanter,[6] 1935, dissection and packing of a pelvic tunnel with epithelization apparently from the vulva; Owens, 1942, split-skin grafts over a mold. Several other technics have been employed, with various difficulties and failures.

The following surgical procedure was performed by two of the authors (G. W. P. and G. B. O'C.) in 1934:

The patient, a Negress age thirty-three, sought consultation in July, 1933. Examination revealed a normal vulva and complete absence

of the vagina except for a small dimple at the lower fourchet. The patient's breasts were well developed and the escutcheon was feminine.

Surgery was proposed, and on July 18, 1934, a skin flap 19 cm. long and 13 cm. wide was delayed on the inner aspect of the left thigh. The ends were not incised.

Eight days later, under local anesthesia, the distal end was freed and replaced.

On August 8th the entire flap, based approximately 4 cm. lateral to the vulva, was raised. A transverse incision was made across the dimple and a tunnel between the bladder and rectum was formed by blunt dissection. This extended up to the peritoneum and provided a vault 10 cm. deep. The abdomen was not sectioned.

The flap was tubed, fat out, and the distal end was closed. It was then turned on its proximal hinge and inserted into the vault. Anchoring sutures of No. 0 plain catgut were placed. The entire tube was packed with vaseline gauze and the free edges of tube and vulvar epithelium were approximated. The donor site was narrowed and covered with a split-skin graft from the right thigh.

Seven days later the pack was removed and the cavity irrigated with saline. After six weeks the pedicle was severed and trimmed. There was no necrosis in any area. The patient was given instructions on daily hygiene and dilatation of the tube with a small water bag.

The patient moved to another part of the country and was not seen until 1954 when she sought consultation concerning a tumor in the right axilla. She stated that she had maintained dilatation with the water bag regularly for over six months following surgery. The first attempt at sexual intercourse had been somewhat painful and slight bleeding had occurred, but subsequent function had been completely satisfactory.

At surgery a small accessory breast was removed from the right axilla. Examination of the previous operative site was made in the presence of all available obstetricians and gynecologists of the hospital staff. With the speculum in place, the observers were asked to comment. Their common expression was "normal vaginal mucous membrane." When they were shown the black, scarred skin of the left thigh and told that the entire vagina had been constructed with a skin flap, they were incredulous. A rugose, pink, moist mucosal surface lined a vault which admitted three fingers. The pH was 5. A biopsy specimen was taken 5 cm. past the introitus, and the microscopic evidence was interesting. Figure 2 shows normal skin, Figure 3 the normal vaginal mucous membrane, and Figure 4 the lining of the constructed vagina. The exact similarity of histology in Figures 3 and 4 is impressive. Vaginal mucous membrane differs from skin in a thinning of the stratum corneum, thickening of the epithelium and a complete absence of hair follicles, sebaceous glands, sweat glands and pigment. Another characteristic of normal vaginal mucous membrane is the presence of large amounts of glycogen in the epithelium. Normal skin has little or none. The sections shown in Figures 5, 6 and 7 were stained for glycogen. Figure 5 shows normal skin and shows little glycogen (dark-staining superficial layer); Figures 6 and 7 show greatly increased glycogen content in the corneal layer. Figure 7 shows even a little more glycogen than Figure 6.

The complete microscopic findings on our biopsy were as follows: *Changes:* (1) complete loss of hair, (2) complete loss of sweat glands, (3) reduction in large elastic fibers, (4) complete loss of pigment, (5) hyperplasia of epithelial cells, (6) increase in number and height of dermal papillae, (7) decrease of keratinization of stratum corneum, (8) increase in epithelial glycogen, (9) increased vascularity in the submucosal tissue. *No changes:* (1) number of keratohyaline granules of stratum granulosum.

These changes are essentially those found by Whitacre and Alden except that our case showed complete absence of pigment. In their case a free full-thickness skin graft was taken from the abdomen of an eighteen year old Negress and was formed around a pyrex mold. Histopathologic examination at twenty-two days showed reduction in pigment and degeneration of sweat glands and hair follicles. At forty-seven weeks the glands and follicles had been lost but depigmentation had not continued. No glycogen could be demonstrated even following administration of estradiol.

At approximately eleven months from the date of surgery Whitacre and Alden listed the state of the graft as follows: *Changes:* (1) complete loss of hair, (2) complete loss of sweat glands, (3) reduction in pigment, (4) reduction in large elastic fibers, (5) hyperplasia of epithelial cells, (6) increase in number and height

FIG. 2. Hematoxylin and eosin stain; section of normal skin.

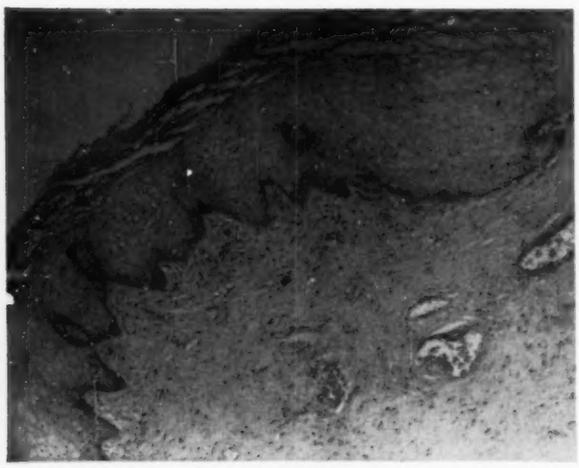

FIG. 3. Hematoxylin and eosin stain; section of normal vaginal mucosa.

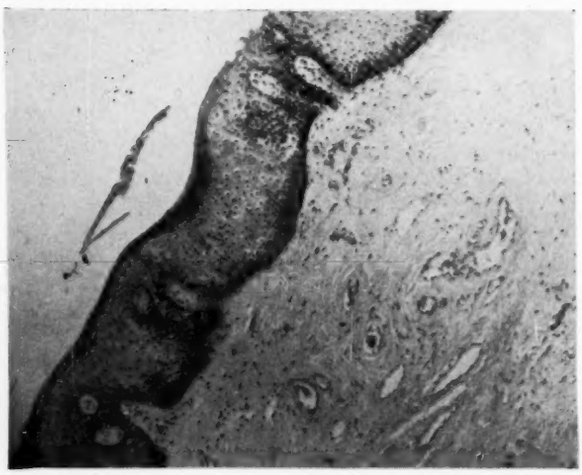

FIG. 4. Hematoxylin and eosin stain; section of constructed vaginal wall.

of dermal papillae. *No changes:* (1) degree of keratinization of stratum corneum, (2) number of keratohyaline granules of stratum granulosum, (3) amount of epithelial glycogen, (4) vascularity.

These two accounts of changes in grafts of skin in Negroes are most striking. However, such changes in artificial vaginas have been noted in varying detail in the literature. Skin grafts to other mucosal areas do not undergo such marked or consistent changes of adaptation. What, then, is the peculiarity of environment affecting skin grafts in the artificial vagina?

The process is not one of metaplasia, for no new cell types are produced. Rather, there is alteration of existing cell layers and the loss of the skin organs. (Metaplasia of an adaptive nature was recently described by Horton.[8] Segments of the ureter in dogs were excised and replaced by formed tubes of split-thickness skin. The change of squamous epithelium to transitional was of such a degree that a search for intercellular bridges was necessary to identify the grafts.)

Where a vagina has been created by simple dissection and packing of the vault, a mucosa has formed apparently from the vulvar mucosa or, possibly, from buried müllerian duct rests (Kanter). It would be difficult to conceive of either of these processes occurring in the presence of a healthy pedicle graft.

The almost teleologic response of the skin flap described herein invites speculation, however faulty, on the broader aspects of environmental influence.

First, the vagina is an elastic sheath of tissue loosely supported in the pelvis. This is duplicated when skin is substituted and kept under tension until healing and softening have occurred. Use further stretches and softens the tissues, and at rest elastic fibers assert themselves and the organ falls into loose folds and rugae, as may be observed on withdrawal of a bivalve speculum.

Second, in the absence of cervical glands the thin, mucoid lubricant coating the surface of the mucosa could be derived only from urine, the glands of Skene and Bartholin, and the products of desquamation.

Third is the loss of pigment. It seems obvious that a prolonged, constant exclusion of light would lead to inactivation of the chromatophores.

Fourth is the loss of the sweat glands. It has long been noted that full-thickness skin grafts to various parts of the body assume the same degree of sweating as the skin adjacent. This eccrine activity is a cholinergic response. The severance of the trophic nerves in grafting, without fibers in the recipient site to re-establish the impulses, would result in atrophy of the glands.

Fifth, a similar loss of trophism may account for the fate of the hair follicles along with their sebaceous glands. Whitacre's findings of degeneration in both hair follicles and sweat glands at twenty-two days indicates an early common catastrophe. Individual attrition due to an unfavorable milieu is less likely to be synchronous. In any case, no report of hair growth in grafts to the vagina has been found.

Sixth, in its new environment the stratum corneum is not subjected to drying or harsh abrasion and pressure. This would allow the outer cells to persist longer and, with constant addition below, could result in a thickened layer. The response to the stimuli of abrasion and pressure, as demonstrated in callus formation, is minimized and cornification is lessened.

Seventh, the increase in glycogen may be a hormonal response as seems apparent in the normal vagina. In Whitacre and Alden's case the blood estrogen level was low. There was no increase in the glycogen content of the mucosa following administration of estradiol but the test period was brief and inconclusive.

We still believe that this flap method is a safe and logical procedure for constructing a vagina where there is complete agenesia, although perhaps the abdomen should be opened. We think that the tissue changes toward the normal of that part are a stimulating and provocative challenge for laboratory study of the phenomenon. Surgically, such a complete functional result is a sufficient source of satisfaction to both doctor and patient.

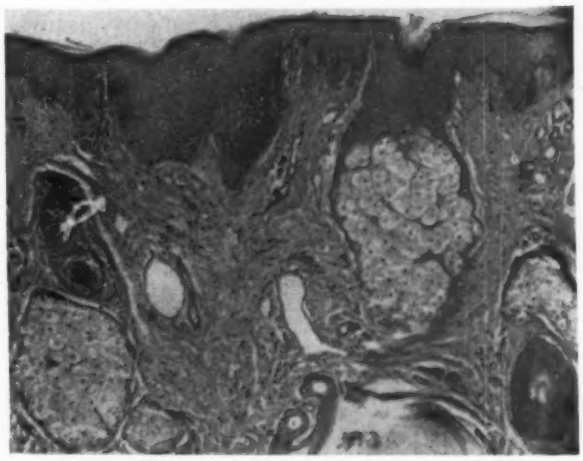

FIG. 5. Glycogen stain; section of normal skin.

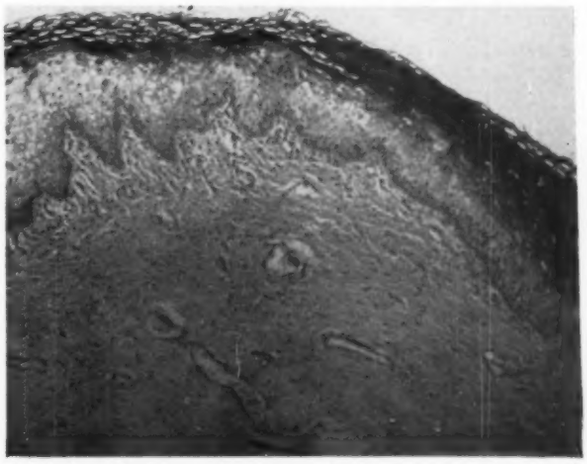

FIG. 6. Glycogen stain; section of normal vaginal mucosa.

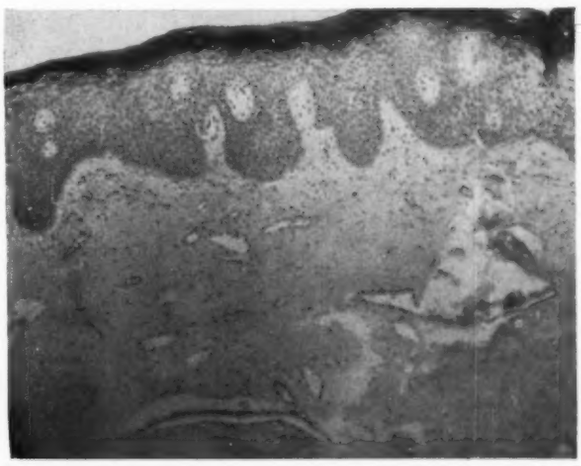

FIG. 7. Glycogen stain; section of constructed vaginal wall.

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A Method of Closure of the Abdominal Wall Defect in Exstrophy of the Bladder

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There are several methods of repair of the abdominal wall defect in exstrophy of the bladder. The size of the defect varies according to the size of the exstrophy, and it may be large. To avoid the stress encountered by a linear closure, we have utilized the bladder musculature as the underlying support and have closed the skin by delayed, interdigitated flaps. (Fig. 1.)

The procedure is carried out in three stages. Ureteral transplantation is performed as the first stage. The second stage consists of the delay of skin flaps. Two flaps based laterally are outlined above the defect. These are elevated for approximately half their distance and sutured in their original positions. This is done in order to increase the blood supply through the base of each flap. At the third stage the bladder mucosa is excised down to the trigone, or the bladder is invaginated and closed. The delayed flaps are again raised, and

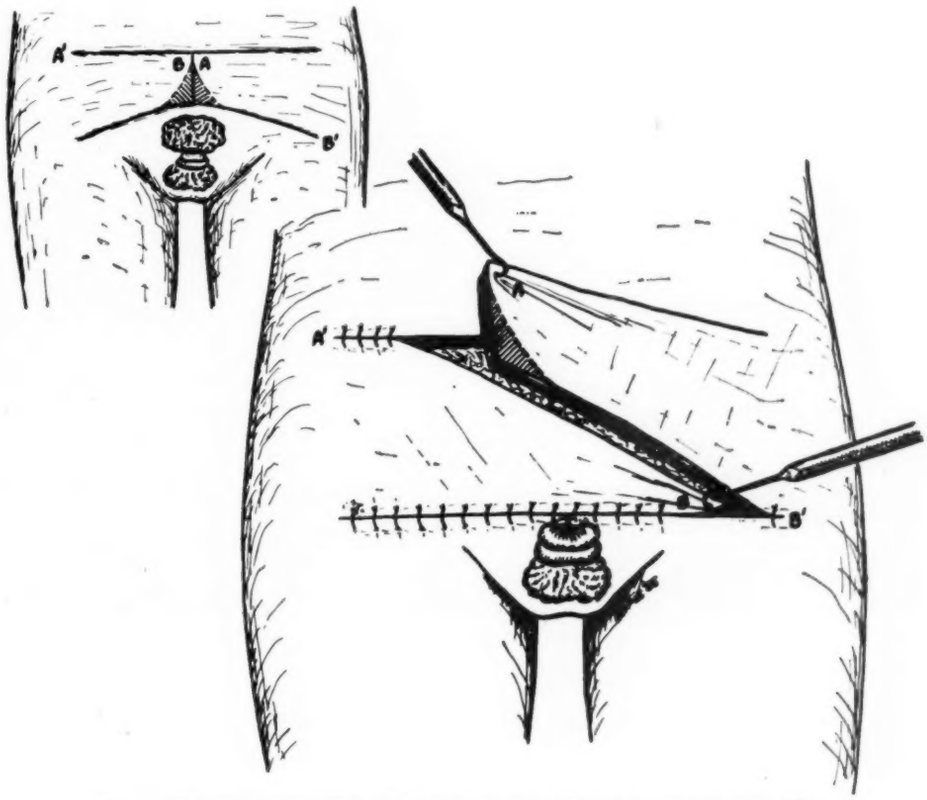

Fig. 1. Diagram of outline of flaps (upper left) and interposition of flaps.

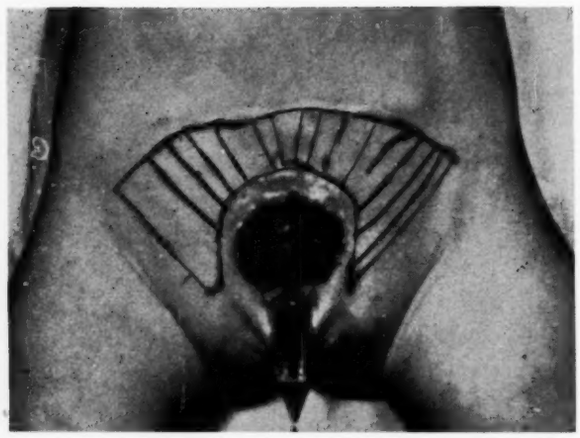

FIG. 2A. Outline of flaps.

FIG. 2B. Three weeks after transposition of flaps.

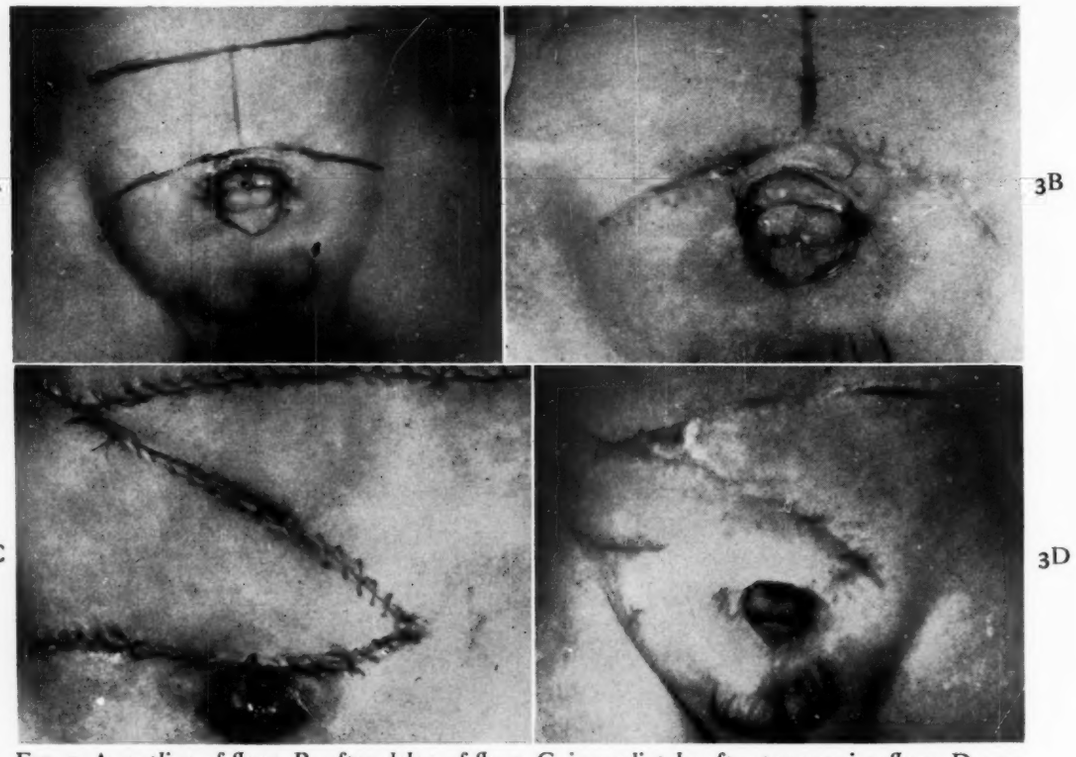

FIG. 3. A, outline of flaps. B, after delay of flaps. C, immediately after transposing flaps. D, one month after transposing flaps.

the edges of scar tissue are trimmed from them. These flaps are advanced inferiorly and interdigitated to cover the defect. The associated epispadias may be repaired at this time in order to improve the cosmetic appearance.

CASE REPORTS

CASE 1. J. B. was first seen at the age of fifteen months. Examination revealed a well developed white male child who was healthy except for complete exstrophy of the bladder with bilateral cryptorchism. A grade III hydronephrosis was found on the left. On October 23, 1953, a right ureterosigmoid transplantation was performed and the left ureter was ligated.

The patient was readmitted to the hospital at the age of nineteen months, and on February 3, 1954, two flaps based laterally were outlined above the defect. The flaps were approximately 4 inches wide at their bases and 2 inches wide at their tips (medial ends). The medial halves of these flaps were elevated. Hemostasis

was secured and the flaps were sutured in their original positions.

Two months later the patient was again admitted to the hospital, and on April 12th the third stage was performed. The mucosa of the bladder was excised down to the trigone. The two delayed flaps were elevated; and after the scarred edges were trimmed, these flaps were advanced downward and interdigitated with each other to produce complete coverage and closure of the abdominal defect. The epispadias was also corrected at this stage by incising the junction of the skin and mucosa, and undermining both by sharp dissection. The mucosal edges were approximated and the skin edges closed. This provided a satisfactory cosmetic result. (Fig. 2.)

CASE II. S. W., a sixteen month old white male child, appeared healthy except for moderate exstrophy of the bladder with associated epispadias. On October 19, 1954, the first stage of repair was performed by transplanting the ureters into the sigmoid colon.

The second stage of repair (delay of abdominal flaps) was carried out on January 3, 1955. One month later the third stage (advancement of flaps) was performed. The bladder was invaginated and closed. The delayed skin flaps were then raised, advanced downward and interdigitated over the area of the abdominal wall defect. The epispadias was also repaired at this stage. (Fig. 3.)

SUMMARY

Two cases of exstrophy of the bladder have been reported in which the principle of retaining the bladder wall and covering the defect with delayed, interdigitated abdominal flaps was employed.

Internal Wire Fixation of Facial Fractures

A FIFTEEN-YEAR FOLLOW-UP REPORT

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FOR the past fifteen years, internal wire fixation has been employed in all facial fractures requiring support and fixation. The general technic has varied very little from that reported in 1942.[1] It is even more apparent that extraoral and external fixation appliances are unnecessary.

FIG. 1. Caricature of a facial fracture patient's interpretation of being treated with an external appliance to a headcap.

There are many advantages of internal wire fixation. The equipment is simple and readily available at any hospital. This consists of stainless steel wire, small drill points (preferably 1 to 2 mm. in diameter), a hand or electric drill, and a bone elevator (a male urethral sound). Direct wiring of the fractured bony part to the unfractured gives a more complete immobilization. Comparatively no postoperative pain or discomfort is experienced. After the acute stage (usually within one week or ten days) the patient may be up and about and meet people without evoking curiosity as there is no external evidence of the wire fixation.

Disadvantages of and contraindications to external appliances attached to a headcap are outstanding. At best, they give only partial immobilization, as it is impossible to make any type of headcap completely immobile since the skin and overlying soft structures of the skull are quite mobile. Only with the use of pin fixations into the skull would it be possible to make a headcap completely immobile. External appliances attached to a headcap are uncomfortable to the patient from the time they are applied until they are removed. (Fig. 1.) They require close watching and repeated adjustments on the part of the surgeon. Practically any movement of the head causes some movement of the facial fractures. Wires and pins which are attached to the facial bones and brought out through the overlying skin result in disfiguring scars. These appliances are complex, cumbersome and expensive, with the exception of the case in which coat hanger wire is incorporated into the plastic cap. Coat hanger wire has all the disadvantages of the other external appliance. Many patients with facial fractures also have lacerations of the forehead or scalp, or fracture of the skull; a headcap applied in this type of case makes it impossible to give proper care to the head wounds.

Today, extensive compound facial fractures are probably ten times more frequent than they

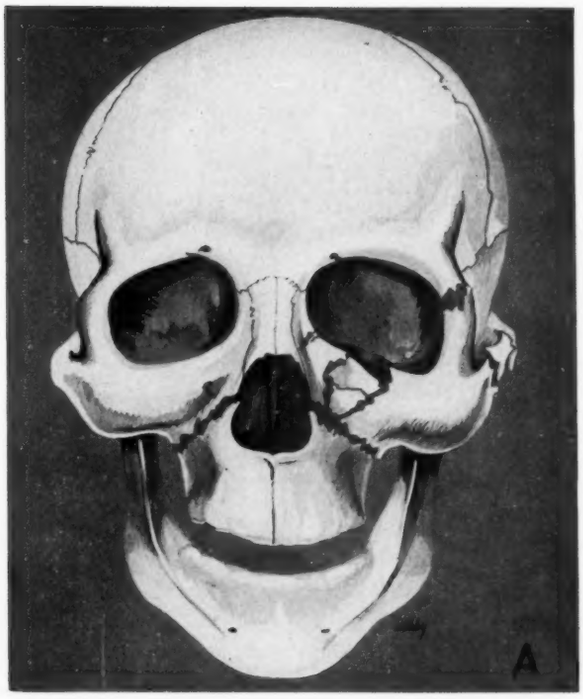

FIG. 2A. Horizontal fracture of the maxilla, left xygomatic arch and left malar bone in an edentulous patient.

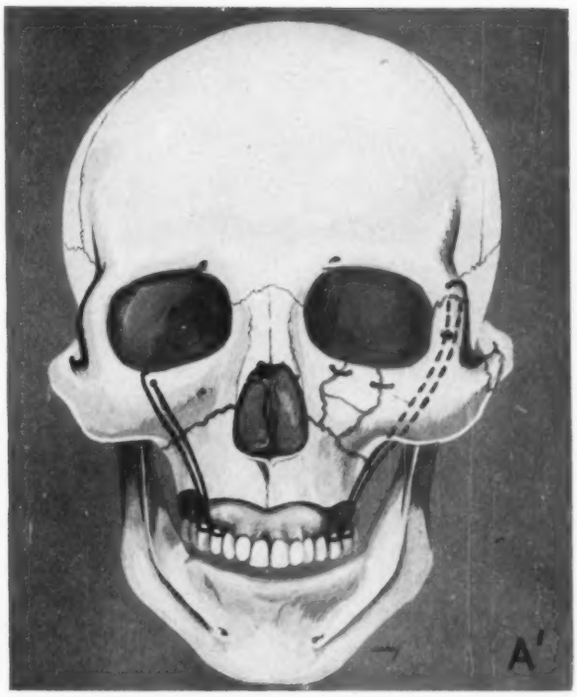

FIG. 2A'. Wire fixation with use of upper artificial denture.

were fifteen years ago. It is not unusual to see several of these patients on a plastic surgery service at the same time. Automobile accidents are still the most common cause of facial injuries. With the continued yearly increase in the number of automobiles and the increase in horsepower and speed, facial injuries and accidental death increase proportionately. For many years plastic surgeons and other surgeons interested in traumatic surgery have encouraged the automobile manufacturers to give more attention to safety measures, eliminating protruding objects from the interior of the car, especially on the instrument panel and doors. The use of soft sponge rubber or similar material over common danger points would help eliminate this hazard. Safety belts should be included on all cars as standard equipment. Severe injuries and deaths from automobile accidents might be reduced 50 per cent if the manufacturers would utilize all the known safety devices in their cars.

In 1942 a series of eighty-five cases was reviewed to determine the distribution and combination of facial fractures associated with fractures of the maxilla.[1] Although many cases of this type have been treated since that time, this year a series of eighty-five consecutive cases was studied for comparison. It is very interesting to note that the distribution of the two series of each eighty-five cases is practically the same. (Tables I and II.)

TABLE I
1942 STUDY

Fracture of the mandible	19
Fracture of the zygoma	22
Fracture of the nasal bones	16
Fracture of the skull	5
Facial lacerations	50
Deaths	3

TABLE II
1952 STUDY

Fracture of the mandible	21
Fracture of the zygoma	23
Fracture of the nasal bones	13
Fracture of the skull	1
Facial lacerations	47
Deaths	2

Fractures of the facial bones occur in a variety of combinations. The plan of treatment for each patient is determined by type and location of the fractures. (Fig. 2.)

All facial fractures do not require fixation. This may be true if there is a greenstick fracture, or if there is not a complete detachment

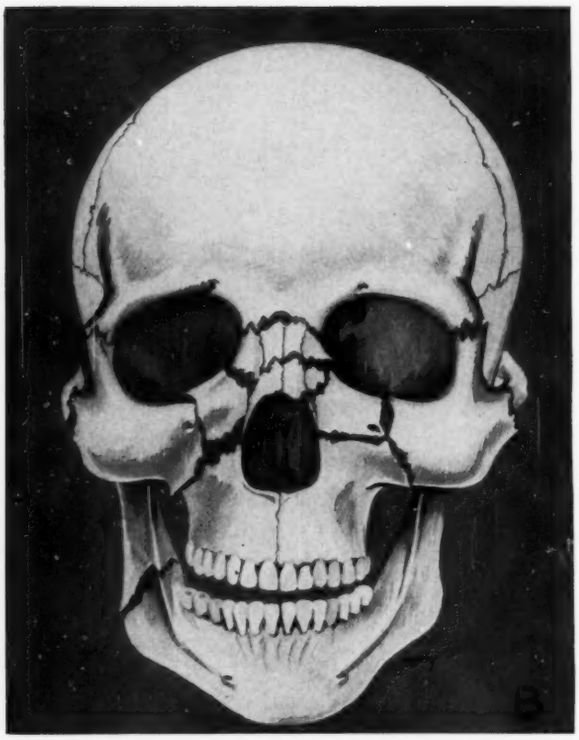

FIG. 2B. Bilateral fracture of maxilla, nose, zygomatic arches, malar bones, and right mandible at the angle.

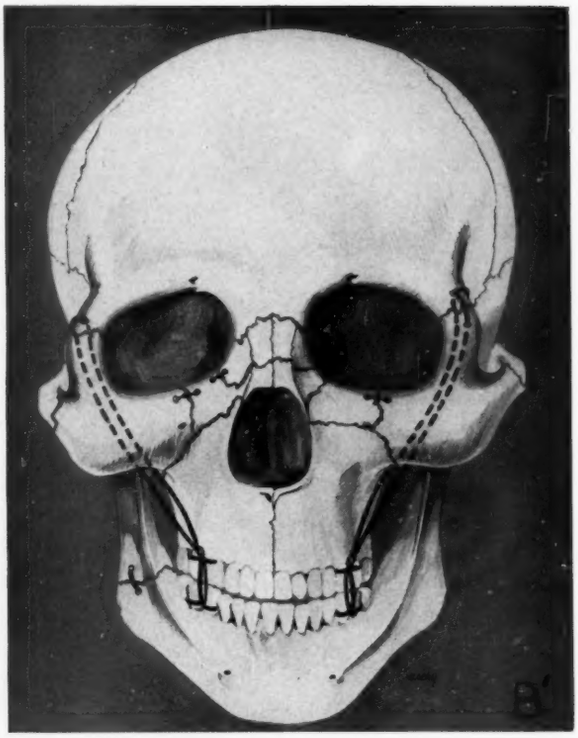

FIG. 2B′. Points of wire fixation for immobilization.

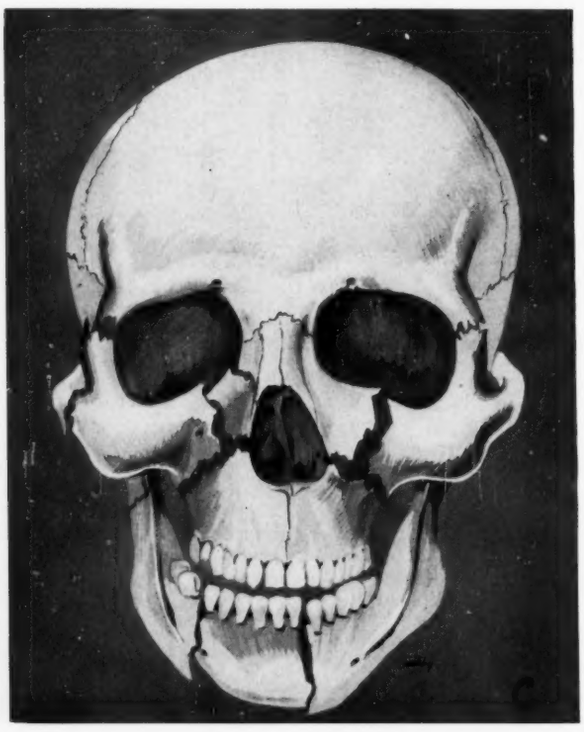

FIG. 2C. Fracture of maxilla, nasal and malar bones, and multiple fracture of mandible.

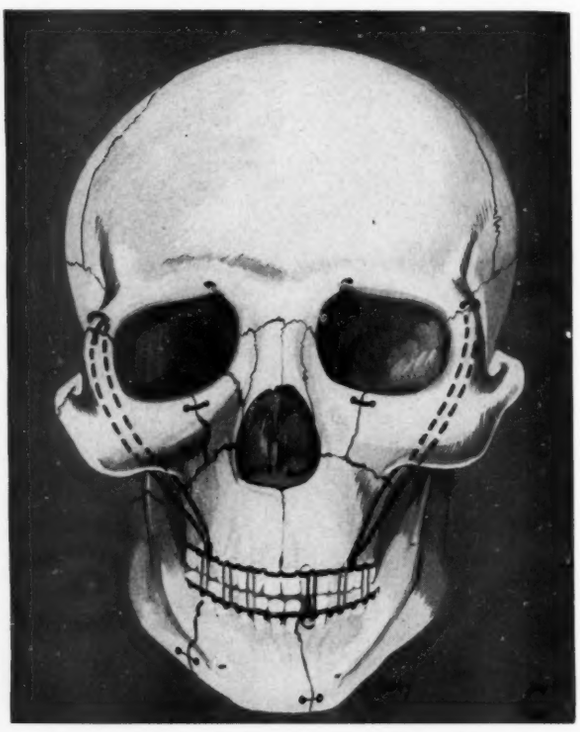

FIG. 2C′. Points of wire fixation for immobilization.

of a bony part, or in case there is a fracture of a single bone and after reduction the bony part locks in place.

DIAGNOSIS

The diagnosis of facial fractures offers minimal difficulty. Accurate diagnosis by clinical examination can be made in most cases. Signs and symptoms suggesting fracture are periorbital ecchymosis, double vision, anesthesia of the cheek and upper teeth, and asymmetry of the palpable bony parts.

Diagnosis by palpation may be more difficult twenty-four to forty-eight hours following injury due to swelling of soft tissue.

A diagnosis should always be substantiated by x-ray examination. Modified Waters views of the facial bones frequently demonstrate fractures not apparent on usual postero-anterior and lateral views. Mentovertex views will demonstrate anteroposterior displacement of the infraorbital rim. These views also are good to show depressed fractures of the zygomatic arch. Special views are necessary for demonstration of fractures in the region of the temporomandibular joint.

ANESTHESIA

If general anesthesia is contraindicated, the procedure is done using local anesthetic alone. Our choice of anesthesia for the average case is intravenous injections of pentothal® sodium combined with local infiltrations of 1 per cent novocain,® with suprarenin. Pentothal is used for the purpose of basal sedation and not solely as an anesthetic agent. In this routine it is the responsibility of the surgeon to remove all blood and secretion from the naso-oropharynx. In rare cases, when there is a problem of maintaining adequate airway, intubation and inhalation type anesthesia is used.

Patients who are poor anesthetic risks, due to recent ingestion of food or acute alcoholism, are given emergency treatment only. Definitive treatment of the facial injuries is delayed for six to eight hours until the patient can be properly prepared for surgery.

TECHNIC

After the diagnosis has been made, one should visualize the fractured parts in their architectural relationship to the normal bony structures, without regard for the overlying soft tissues. The treatment then should be relatively simple. The soft tissue wounds should, of course, be treated in the usual manner.

Fractures of the maxilla are rarely encountered alone; rather, they are generally associated with fractures of one or more of the other facial bones, including the mandible. The maxilla is the central supporting structure of the face. Anatomic position and immobilization of this structure is of prime importance. After the maxilla is fixed, reduction of the other facial bones is less difficult.

In open reduction and fixation of fractures of the malar compound, it is necessary to make an incision at only one or two sites; overlying the infraorbital ridge, or at the lateral margin of the supraorbital ridge over the zygomaticofrontal suture line, depending on the location of the fractures. In the event of a laceration over either of these areas, the wires may be inserted through the wound.

In unilateral fracture of the maxilla, with separation in the midline, the teeth on the fractured side are fixed to those on the sound side. In many cases a simple loop is sufficient, although in more complicated cases when teeth have been lost, an arch band may be required.

In a simple bilateral fracture of the maxilla, a small incision is made over the infraorbital ridge on either side. A hole of sufficient size to accommodate a No. 25 or 26 stainless steel wire is bored through the infraorbital ridge. The wire is then threaded through the opening, looped over the ridge, and both ends are passed together along the anterior wall of the antrum into the upper sulcus over the second molar teeth. One is surprised at the ease with which the wires are directed to the desired point of exit without the use of a guide. (Fig. 3.) The fractured bone is then elevated to its normal position and the wires are drawn taut and fixed to one or more of the teeth. The use of the loop around the infraorbital ridge is much simpler than tying the wire, and its subsequent removal is more easily accomplished.

If the patient is edentulous, the wires may be attached to the false plate, provided it is intact (Figs. 2A and A′); otherwise, dental wax may be molded around the alveolar ridge and over the hard palate, the wires drawn across the palate and tied in the midline. The sharp ends of the wire are imbedded in the wax.

In fractures extending through tooth sockets, the involved teeth do not have to be extracted

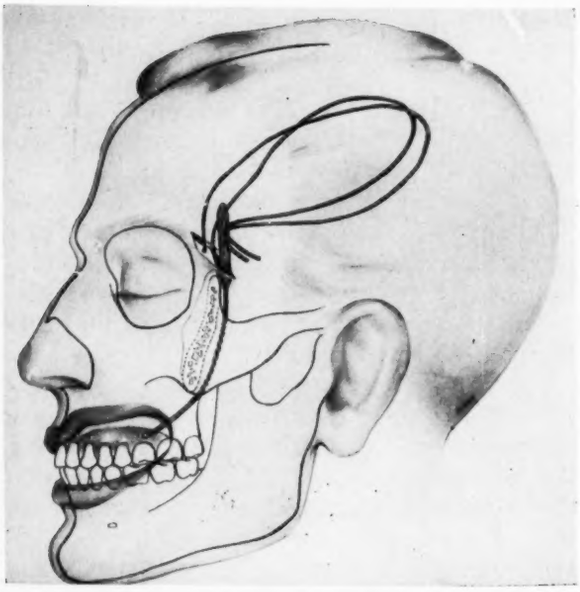

FIG. 3. Illustrates the use of a dissecting probe for carrying the stainless steel wire from the supporting fixation point, which is the zygomatic process of the frontal bone, down and behind the body of the zygoma and through the mucous membrane of the upper sulcus into the mouth at the upper first molar region.

immediately. These teeth are important as space maintainers and facilitate immobilization of the fracture in a reduced position, and with the use of antibiotics, incidence of dental abscesses has not been encountered in the last eighty-five cases treated.

Once the wires enter the contaminated field of the mouth, they should not be drawn upward through the soft tissues. If removal is necessary, the loop should be cut and the wires withdrawn from below.

In fractures of the maxilla associated with comminuted fractures of the infraorbital ridge, it is necessary to immobilize the major fragment of the ridge to the outer half. (Figs. 2C and C′.) This may be done through the same soft tissue incision. An additional hole is drilled through the medial fragment and a small loop of wire is inserted through the two holes and tied. The smaller fragments, after restoration to their normal position, will usually remain in place, being supported by the immobilized large fragment. Following wire fixation of the infraorbital ridge, intra-antral packing with gauze or other substance is usually not necessary. In cases of complicated fractures with displacement of the orbital floor, it may be necessary to support these fragments of the orbital floor with packing in the maxillary antrum (vasolined iodoform gauze). In those patients not requiring antral packing, a naso-antral window is made under the inferior turbinate to faciliate drainage of the sinus.

For reduction and immobilization of fractures of the maxilla with associated fractures of the zygoma or malar process, an incision is made over the ridge of the frontal bone lateral to the supraorbital rim, just above the zygomaticofrontal suture line. The periosteum is separated from the frontal bone with an elevator and a small hole is drilled through the ridge. A wire is threaded through the opening, looped over the ridge and the two ends are passed beneath the temporal surface of the malar bone, making their exit in the upper sulcus in the region of the first or second molar. The displaced bones are elevated to their proper positions and the wires are tied to the teeth, exerting an upward and outward pull on the malar bone and holding it up in normal position. Should there be any question as to the adequacy of fixation, one should not hesitate to drill another hold in the malar bone just below the zygomaticofrontal suture line and, with a small loop of wire, fix the malar bone to the zygomatic process of the frontal bone. (Figs. 2B and B′.)

In these cases the malar bone and zygomatic process may be elevated by several other methods. By such methods, however, the malar bone, if completely detached, may subsequently be displaced by the strong pull of the masseter muscle. With the procedure described the bones are restored to their normal positions and the malar bone is firmly fixed to the frontal bone by wiring. Associated fracture of the zygomatic arch after reduction does not require fixation, since it has adequate support from the underlying temporal muscle.

Following reduction and immobilization of fractures of the maxilla and other facial bones, associated fractures of the nasal bones are reduced and maintained in position by a nasal splint, according to the routine method of treating such fractures when encountered alone.

In bilateral fractures of the facial bones the foregoing procedures are carried out, as indicated, on both sides (Figs. 4A and B.) In bilateral horizontal fractures of the maxilla, with separation in the midline, the two halves are drawn together and immobilized with arch bands or wires. This should precede open reduc-

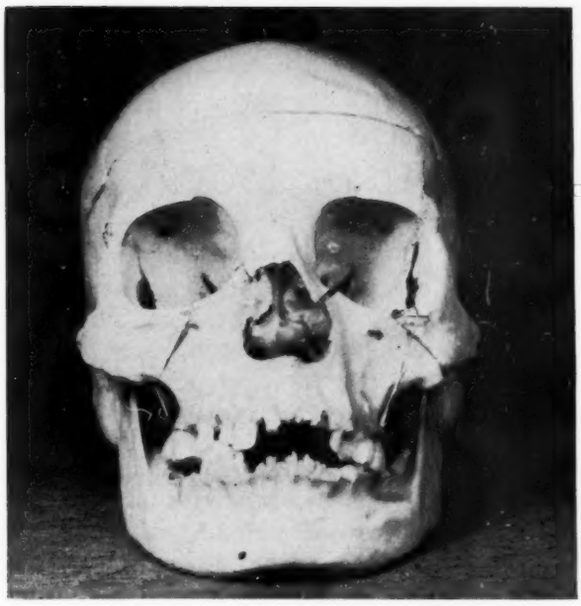

FIG. 4A. Anterior projection of a skull. With a saw, the facial bones have been severed at the sites of most usual fractures encountered. These fracture sites have been wired according to the method described within this article.

FIG. 4B. Lateral projection of a skull. The most common sites of fractures of facial bones have been simulated by transecting the bones with a saw. The method of fixation with wire is clearly demonstrated.

tion and fixation of the maxilla to the upper unfractured bones. If the mandible is not fractured, fixation of the upper to the lower jaw is unnecessary.

Oral hygiene is of utmost importance. The mouth should be regularly irrigated after each feeding, using a large irrigation unit with 3 feet of tubing, to which a hard rubber or metal irrigation tip is attached. There should be sufficient force to the stream of water to cleanse the mouth thoroughly. In addition to this method, the patient should brush his teeth using a (baby) toothbrush.

Patients with compound fractures are routinely given prophylactic tetanus antitoxin. All patients with facial fractures are given antibiotic therapy. Blood transfusions and shock treatment are given as indicated.

Diet consists of liquid or semi-soft foods. Balanced caloric intake may be facilitated by the use of puréed meats, protein hydrolysate and frequent feedings of stock formula, supplemented with multiple vitamins and minerals.

The wires are allowed to remain in place for three to five weeks, depending upon the location and type of the fracture. One may feel free to leave them undisturbed as long as necessary since they cause little or no discomfort.

After healing is complete the wire is severed through a small spearpoint incision over the loop and is removed through the mouth, in order to avoid contamination of the soft tissues above.

Nature is kind in the treatment of these facial injuries; the blood supply of the tissues is abundant and healing takes place quickly. The scar over the infraorbital ridge, being horizontal, is almost invisible, and that over the supraorbital ridge is inconspicuous at the outer edge of the eyebrow.

SUMMARY

This report is presented to re-emphasize a method of treatment of facial fractures which we have used routinely for the past fifteen years. Results have proved that this is the ideal method of management of facial fractures. With the advent of new antibiotics, the incidence of complications has been further reduced.

REFERENCE

1. ADAMS, W. M. Internal wiring fixation of facial fractures. *Surgery*, 12: 523–540, 1942.

The Surgical Management of Local Postradiation Effects

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RADIATION therapy is a two-edged sword. It produces great benefit when properly administered in the treatment of malignancy but is followed by a series of progressive and irreversible changes terminating either in varying degrees of radiation sclerosis, at times in postradiation necrosis or occasionally in epitheliomatous neoplasia eight to thirty-five years after therapy. In the treatment of benign conditions radiation, although given in smaller amounts, may be given over a protracted period by several or more therapists, each without the exact knowledge of the previous dosage. It is this group which constitutes the larger bulk of postradiation cases seen by the surgeon performing reconstructive surgery. There is another large group composed of physicians, dentists, physicists and technicians suffering from these effects as the result of occupational overexposure. With the coming of the atomic age, atomic radiation lesions will become more frequent. These lesions differ only in that the development is faster than in the cumulative x-ray burn due to the excessive exposure in a short space of time. The victim may receive 10,000 to 12,000 r in a few seconds.

Because of the all too frequent misunderstanding both among the profession and the laity with regard to the problem of "x-ray burn" and its frequent medicolegal complication, I shall attempt to present the essential known facts with regard to the biophysics of radiation and its long term beneficial as well as pathologic effects. It is believed that the "interests of the patient with malignancy" would be served best by the establishment of a combined radiotherapy–cancer surgery clinic utilizing the team approach.

BIOPHYSICS OF RADIATION

According to Regaud,[1] the biologic effects of ionizing radiations may be divided as follows: (1) the diffuse cytocaustic effect which differs in no way from that produced by the excessive application of cold, heat or caustics; (2) the selective cytolethal effect which is the result of ionization produced by the collision of the radiations with the components of living tissue. This may lead to: (*a*) immediate death of cells; (*b*) damage due to absorption of a large number of particles destroying some of the cellular constituents (only after the cells undergo mitoses) resulting in delayed growth; (*c*) an effect appreciable only in the cells' descendants, e.g., radiated sperm leads to abortion and sterility, and radiated grain produces anomalies due to the destruction of varying quantities of nuclear chromatin which make up the genes.

Living tissues react differently to radiation. Tissues composed of uniform cells, (e.g., nervous system, bone and muscle) show poor radiosensitivity. Their injuries are the indirect result of impaired vascularity and fibrosis. Tissues of multiform cells in continuous state of transformation are very radiosensitive (e.g., epidermis and seminiferous tubules). According to the law of Bergonie and Tribondeau,[2] the effect of radiation on living tissues is the more intense (1) the greater their reproductive activity, (2) the longer their mitotic phase lasts, and (3) the less their morphology and function are differentiated.

According to Warren,[3] the effect of radiation on a given tissue is proportionate to the amount absorbed. The radiant energy (photon) may traverse without absorption. It may if it collides with an electron be entirely expended (photoelectric effect), or it may by removing an electron from an atom expend only part of

its energy and continue in a changed direction, in which case the wave length will become longer (Compton's effect). Hence the size of the field is the most important factor as to the result of the secondary radiation thus produced.

The rate of administration of radiation is important. With a very low rate, regeneration will compensate for any biologic effect on somatic cells. However, it may be borne in mind that there is danger in the policy of "little and often" inasmuch as each x-ray treatment produces a certain amount of fibrosis and vascular change. Its effect is cumulative, i.e., radiotherapy by geometric progression. Heavy dosage given at a rapid rate will destroy all tissues; at a lesser rate, selective action on radiosensitive tumor cells occurs.

The character of the response is determined by the amount absorbed, the intensity of the radiation and the area exposed. When larger masses of tissue are involved, gamma radiation and supervoltage x-ray produce less change in the skin than do longer wave lengths. The effects of radiation of the skin vary greatly with: (1) the dose delivered, (2) the quality of the radiation, (3) the size of the irradiated area, (4) the region of the body and (5) individual idiosyncrasy. The filter is utilized to absorb the soft rays and thus to harden the beam, thereby diminishing the caustic effect on the skin. The secondary radiation from the tin or lead filters must in turn be absorbed by copper. Secondary radiation from the copper must in turn be absorbed by aluminum. The amount of external radiation that can be given to a patient is limited by the skin tolerance. There is no laboratory yardstick by which to measure tissue tolerance accurately.

PATHOLOGY

The stratum corneum of the skin is most resistant because of its inactive metabolism. The stratum germinativum and basal layer are relatively sensitive. Hair follicles are very sensitive—500 r at 200 kv. leads to temporary epilation and 700 r produces permanent epilation.

According to Borok,[4] the quantity of x-ray given in one dose is considered lethal for tissues as follows: 1,200 r, lethal dose for sebaceous glands; 1,600 r, lethal dose for hair follicles; 2,000 r, lethal dose for epidermis; 2,500 r, lethal dose for sweat glands.

The severe damage to the sweat glands parallels the damage to the blood vessels. Approximately 3,000 r (air dose) filtered radiation at 200 kv. in twenty treatments over a moderate-sized field (Coutard's principle) will produce telangiectasis and the histologic picture of chronic radiodermatitis.

According to Wolbach,[5] the histologic changes are as follows: Within forty-eight hours there is edema of the corium, with swelling and coalescence of the collagen fibrils both in the walls of the blood vessels and in the stroma of the skin appendages. Some connective tissue cells are destroyed; many survive and undergo mitosis leading to the production of new connective tissue. There is early flattening of the rete pegs and shedding of the stratum corneum, occasional parakeratosis, edema of the "prickle cells" and amitotic division in the basal layer. This in turn leads to necrosis of the basal layer and increased pigmentary activity. Wolbach[5] believes that the lesions of the epidermis are secondary to obliteration of the lymphatics and capillaries caused by the changes in the collagen and proliferation of the endothelium. This destruction is greatest in the superficial layers of the corium. There is polymorphonuclear infiltration and necrosis leading to the production of gaps which are filled in by a proliferating epidermis in twelve days following a single exposure. Pigmentation follows due to changes in the vascular bed and intercellular substance.

If the reaction is more severe, the endothelial cells may proliferate so that they completely close the blood vessels. The elastic tissue becomes shredded. The fibroblasts resemble foam cells. The atrophy and sclerosis of the corium gradually progress along with complete disappearance of vessels and skin appendages. Telangiectasis ensues.

To summarize the acute sequelae of radiation: A small dose leads to dry epidermitis; a large dose produces erythema which begins at two and a half to three weeks after the first treatment, becomes more pronounced and reaches its peak with the denudation of the dermis to produce the typical epidermite. It weeps constantly and may become secondarily infected. After a few days there is regeneration of the epidermis from the deeper islands of epithelium. Larger doses produce more intense radiodermatitis which requires a longer time to heal. The skin must grow in from the border. A still larger dose leads to acute radionecrosis

FIG. 1A. Note extreme disturbance of growth resulting from treatment of port-wine stain with radium in infancy.

FIG. 1B. Patient six years following completion of reconstruction of left side of face by shifting and advancement of local tissues following multiple excision of the lesion. The lip and nose have been reconstructed with a cervical tube pedicle flap.

which is irreparable. The major underlying cause of radionecrosis is diminished tissue reserve, with sepsis contributing its share.

As to the permanent sequelae with a small dose, the epilation and dryness of the skin are transitory and the scar is inconspicuous. The larger dose produces permanent epilation, achroma and fibrosis. Atrophy and telangiectasis gradually develop in variable degrees depending on the intensity, region and idiosyncrasy. With intense radiodermatitis there is a long period of breakdown and repair, leading to discolored atrophic skin which may break down years later. The skin is half dead and half alive, with its regenerative and recuperative powers sadly reduced. It cannot easily withstand infection or trauma and its powers of healing are almost non-existent. The maintenance of continuity of the epidermis by proliferation of epithelial cells in the adjacent better nourished periphery constitutes a mechanism whereby constant epithelial hyperplasia is maintained. According to Wolbach,[5] the acquisition of malignant properties follows sustained proliferative activities in contact with an abnormal supporting tissue. The imperfect nutrition from the peculiarly cicatrized corium leads to imperfect differentiation into keratin so that the superficial cells remain attached, resulting in hyperkeratosis and eventually in malignancy. According to Brown, McDowell and Fryer,[6] it is the epithelial activity to cast out the intradermal debris of clots and necrotic cells acting over a long time which may be the ultimate cause of the development of cancer. The effects on mucous membrane are similar except denudation occurs earlier, in from twelve to fourteen days. The lesion (radioepithelitis) is covered with diphtheritic-like membrane and the repair may be rapid or delayed depending on dosage.

Bone, being vascular, holds up fairly well under radiation. Tendon, nourished by a fairly vascular but excessively delicate paratenon, occupies an intermediate position. Cartilage, because of its poor blood supply, is extremely susceptible. This is true particularly in the nose and ear. Young growing cartilage and bone are extremely vulnerable so that radiotherapists prefer not to use x-rays in the vicinity of epiphyses of long bones. It does not appear to be well recognized that the growing facial skeleton is equally vulnerable. According to Wendeyer,[7] heavy radiation over bone and cartilage causes changes which are permanent. The effects may not be apparent radiologically and may be

FIG. 2A. Note marked atrophy of entire right orbit, malar and forehead area two years following enucleation of right eye for retinoblastoma followed immediately with intensive x-ray therapy.

FIG. 2B. Photograph of same patient three years after reconstruction of orbital and forehead areas with a cervical tube pedicle. Larger prosthetic eye will be needed.

present without obvious changes in overlying soft tissues. There is much greater absorption in bone and cartilage because of their composition with larger amounts of heavier elements. The blood supply is restricted by endarteritis. Growth of teeth is also retarded by radiation. A peculiar form of dental caries with painless amputation of the teeth can also occur. Radiation about the eye leads to cataract and in certain instances to destruction of the eyeball.

Pain is a salient feature of all cases of radionecrosis and some cases of healed radiation dermatitis. If the cutaneous nerve ends are involved, a severe burning sensation limited to the area is produced. This has made drug addicts of many persons. Radical block excision of the involved tissue provides complete relief of pain. If on the other hand the sensory nerve is involved, the pain is more intense and radiates along the distribution of the plexus.

IDIOSYNCRASY

The use of this term has decreased in about direct proportion to improvement in technic and knowledge, but minor degrees of tolerance variation are common. Certain types of skin have increased sensitivity to radiation. In general, the heavier the skin pigmentation the more radiation is necessary to produce cutaneous injury. The skin of infants is much more sensitive than adults. Skin in certain areas of the body (perineum, lower leg, etc.) are more sensitive to radiation effects. In brief, the skin of exposed extensor surfaces is more resistant than the skin of protected areas. Patients with diabetes, Graves' disease, vasomotor disturbances or obliterative peripheral vascular disease are predisposed to an unfavorable x-ray reaction. Skin diseases such as acne rosacea, psoriasis and mycosis fungoides decrease the patient's tolerance to x-ray. There is, unfortunately, no laboratory yardstick by which one may accurately measure tissue tolerance.

TREATMENT

Disturbance of Growth. Although it is now generally believed by radiotherapists that radiation over the epiphyses of long bones should be avoided in order not to interfere with growth, it does not appear to be well recognized that the growing facial skeleton is

FIG. 3A. Extensive necrosis following intensive radiation, 6,000 r, to large fungating carcinoma.

FIG. 3B. Lateral view of patient one year following reconstruction.

FIG. 4A. Acute radiation necrosis following treatment of subacromial bursitis by a recent medical graduate using his grandfather's x-ray machine. The radiation reaction was treated with hot moist packs and methyl salicylate, which actually intensified the x-ray reaction and precipitated the present catastrophe. When the patient was brought into the hospital, she was suffering from an acute hallucinatory psychosis due to the intense pain.

FIG. 4B. Lesion was excised *en bloc* down to the shoulder joint and reconstructed with a delayed flap from the left breast. Within forty-eight hours after excision of the lesion, the patient's acute psychosis had cleared up completely and she was well orientated as to time and place. The lesion has remained healed for several years following surgery and the patient has been very active both in her home and in her community.

equally vulnerable. In our series there were twelve cases of definite arrested development. It would appear that the earlier in childhood and the larger the amount of radiation given, the greater the disturbance in growth. (Fig. 1A). These facial skeletons were reconstructed when they had attained their maximum growth. (Fig. 1B.)

For the past three years we have been watching several cases in which the heavily radiated area was excised and reconstructed with normal tissue moved in from a distance. (Fig. 2A.) So far we have been encouraged by the amount of growth attained when the vascularity of the area has thus been improved. (Fig. 2B.)

Acute Necrosis. When heavy radiation is

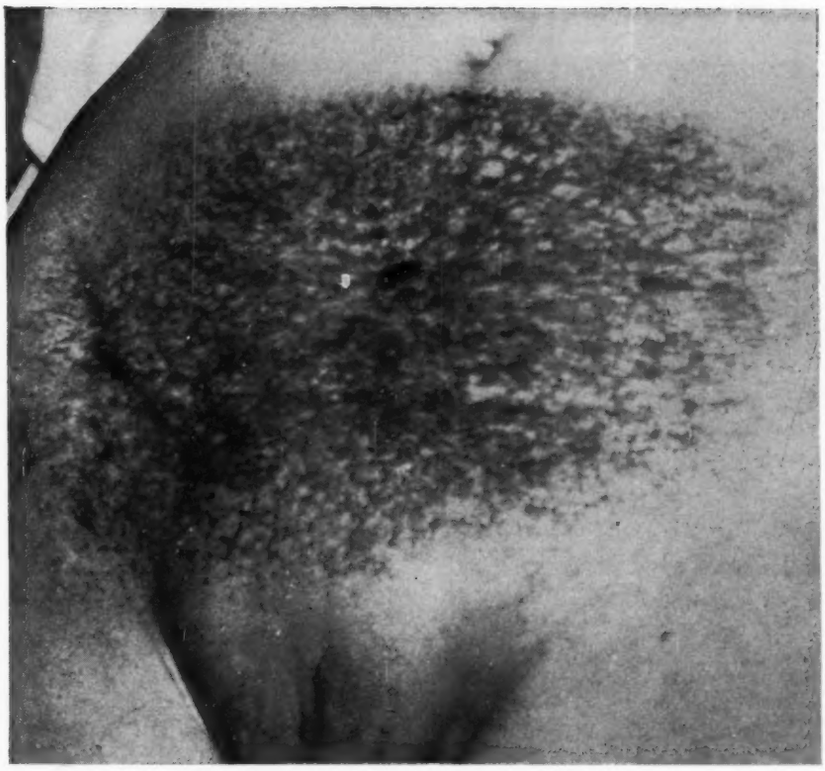

FIG. 5A. Radiation dermatitis with beginning ulceration thirteen years following control of uterine bleeding with x-ray.

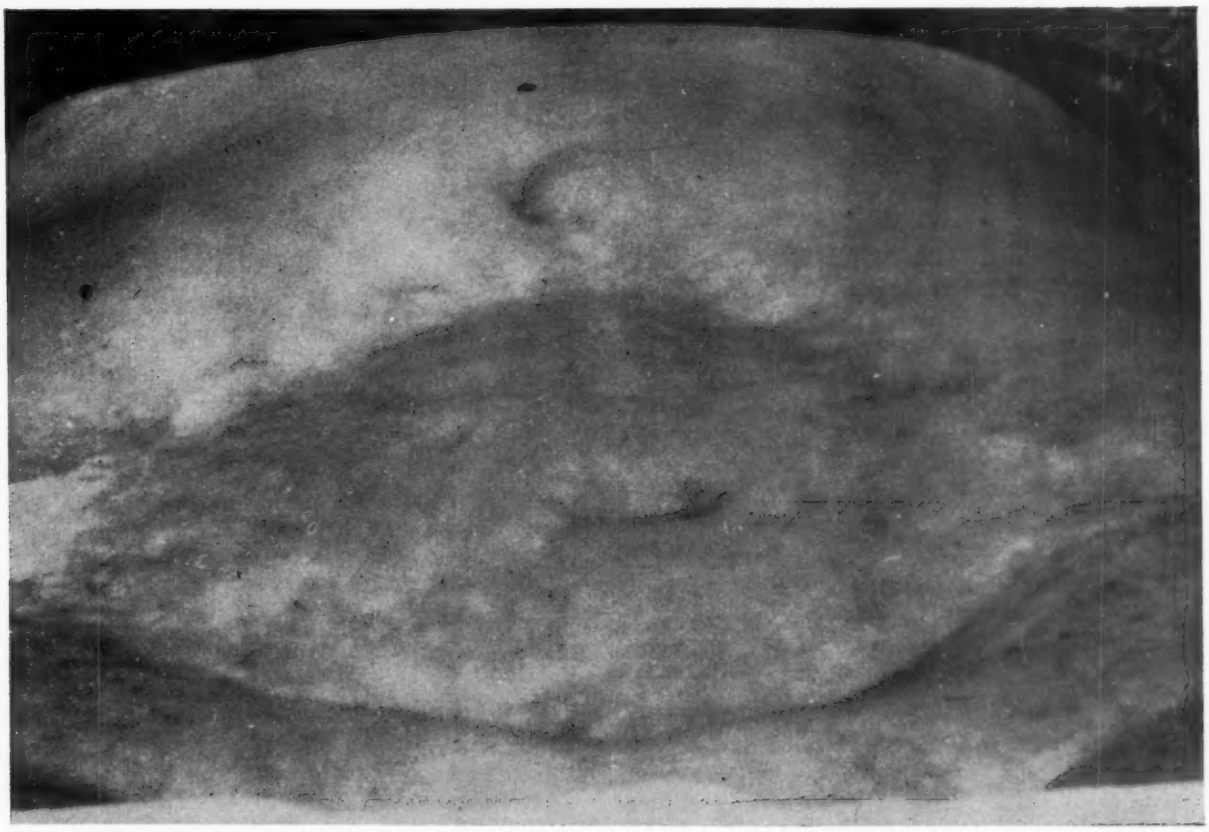

FIG. 5B. Healed condition of wound several years after radical excision of area followed by immediate reconstruction with deep intermediate skin grafts.

FIG. 6A. Multiple squamous cell carcinomas of lower and middle third of face and neck arising in an area of radiation dermatitis (twenty-five years following use of depilatory x-ray). Note construction of bilateral lower cervical tubes to be utilized for reconstruction. Patient extremely morose and unable to obtain employment.

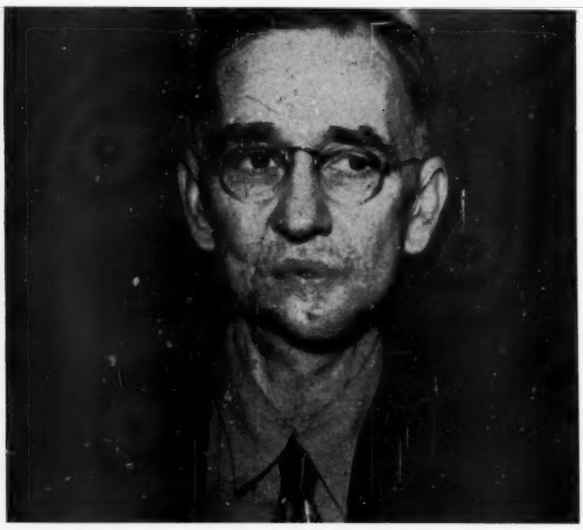

FIG. 6B. Frontal view of patient two and a half years following resection of lower third of face and neck for radiation dermatitis and multiple associated squamous cell carcinomas. This was followed by immediate reconstruction using cervical tubes. Patient is now happy and employed.

given to control local malignancy and the dosage is pushed to 6,000 to 7,000 r, one may expect destruction not only of the malignancy but also of the surrounding normal tissue as well. (Fig. 3A.) This is accompanied with severe pain. The damage is wider than the postradiation stigmas suggest. There is no definite plane of cleavage. Wide block excision will relieve the pain but will result in further sloughing of exposed tissue unless the area is immediately reconstructed with either local flaps or with a jump flap of tissue from a distance. In short, the progressive obliterative endarteritis and fibrosis are so marked that there is scarcely any tissue reserve. In order to attain healing, the tissue used to reconstruct the area must carry its own blood supply with it. (Fig. 3B.)

When excessive radiation for a benign condition from an uncalibrated x-ray machine (given by a tyro) is followed with a severe reaction and in turn is treated with hot moist packs and methyl salicylate as an irritant, one may expect acute necrosis because the treatment has actually intensified the x-ray reaction and has precipitated a catastrophe. (Fig. 4A.) The pain in these may be so severe as to precipitate an acute psychosis or at least make a drug addict of the victim. Radical block excision of the area brings about immediate relief of pain. However, one must be ready to reconstruct the area immediately with a flap. As a result of bringing in new blood supply, the further progress of the lesion will be stopped and the patient rehabilitated. (Fig. 4B.) If this is not done, the sloughing of the poorly vascularized base continues to extend. In our series there were eight cases of acute extensive necrosis.

Postradiation Sclerosis. Postradiation sclerosis is comparable with radionecrosis but is without ulceration. It is characterized by an intact shiny telangiectatic skin with dense sclerotic changes involving the subcutaneous tissue and underlying muscles. Associated with this is stiffening due to fibrotic changes in the capsule of the neighboring joints. The telangiectasis is very marked and this compensatory mechanism possibly accounts for the increased blood supply. This skin is half dead and half alive, with sadly reduced regenerative and recuperative powers. It cannot withstand the infection of trauma easily and its powers of healing are almost non-existent. There is a latent period of from seven to thirty-five years (in one instance forty-five years in our series) before the progressive changes may result in malignancy. According to McIndoe and coworkers,[8] the incidence of neoplasia is about 20 per cent. Leddy and Regis[9] reported malignant epitheliomas in 33 per cent of 115 physi-

cians with radiodermatitis, indicating that these men waited for their lesions to progress further before seeking surgical intervention.

It is during this interval that radical prophylactic block excision of the entire involved area will eliminate the danger of malignancy. (Fig. 5A.) Reconstruction may be usually accomplished in this type with skin grafts. (Fig. 5B.) Occasionally if the radiation has been intense and the process is very severe, reconstruction with flaps may be necessary in order to obtain permanent healing. On weight-bearing surfaces it is imperative to reconstruct the defect using either local flaps or flaps of tissue from a distance (cross leg, cross thigh or jump flaps).

Neoplasia. In the vast majority of healed radiation lesions the resulting scar is inconspicuous except to the trained eye. In the more lightly treated cases, biopsies taken three years later reveal very little. As indicated earlier, any patient receiving 3,000 r or more may have atrophy, obliterated blood vessels, telangiectasis and hyperkeratosis. Definite epitheliomatous change has occurred in previously stable radiation scars eight to forty-five years later. The larger number occurred in a group fifteen to twenty-five years after radiation. It is rather interesting to note that this epidermal instability does not appear to be related to dosage or subsequent trauma. In one case of radiodermatitis carefully followed up with histopathologic examination, multiple small squamous cell carcinomas occurred almost simultaneously within the scar twenty-six years following radiation. In our series of ninety-three cases carcinoma has occurred in seventeen (18.3 per cent). The shortest time interval between radiation therapy and diagnosis of carcinoma is eleven years. The average time interval is twenty years, and the longest time interval was forty-five years.

Since most of these lesions are squamous cell carcinoma, radical block dissection including the regional lymph nodes is required. Plans must be made for the immediate reconstruction once careful frozen section technic has revealed the extirpation of the tumor to be complete. This is accomplished as the situation demands, either with grafts or flaps of tissue from a distance. (Figs. 6A and B.) Occasionally basal cell carcinomas and sarcomas occur following radiation. It may be that these basal cell lesions are coincidental. The occurrence of true sarcoma is very rare.

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Reconstructive Problems of the Chest and Breast

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RECONSTRUCTIVE surgery of the breast is concerned with the modeling of viable tissue to re-form a breast which is defective in shape or size due to congenital causes, trauma, or occasionally infections or neoplastic disease. Reconstruction of the thorax presents the additional problems of motion with respiration coupled with the necessity of stability of the chest wall.

HYPOMASTIA

Hypomastia in the female due to hypogonadism may present a very real problem to the individual. In its most severe forms in conjunction with agenesis of the vagina, the construction of the breast form may be almost as fundamental as the creation of a vagina in the rehabilitation of the patient. In our experience, the administration of hormones has resulted in limited development of the mammary tissue in this type of breast, and the possible ill effects from prolonged overdosage has been emphasized by Geschichter[1] and others.

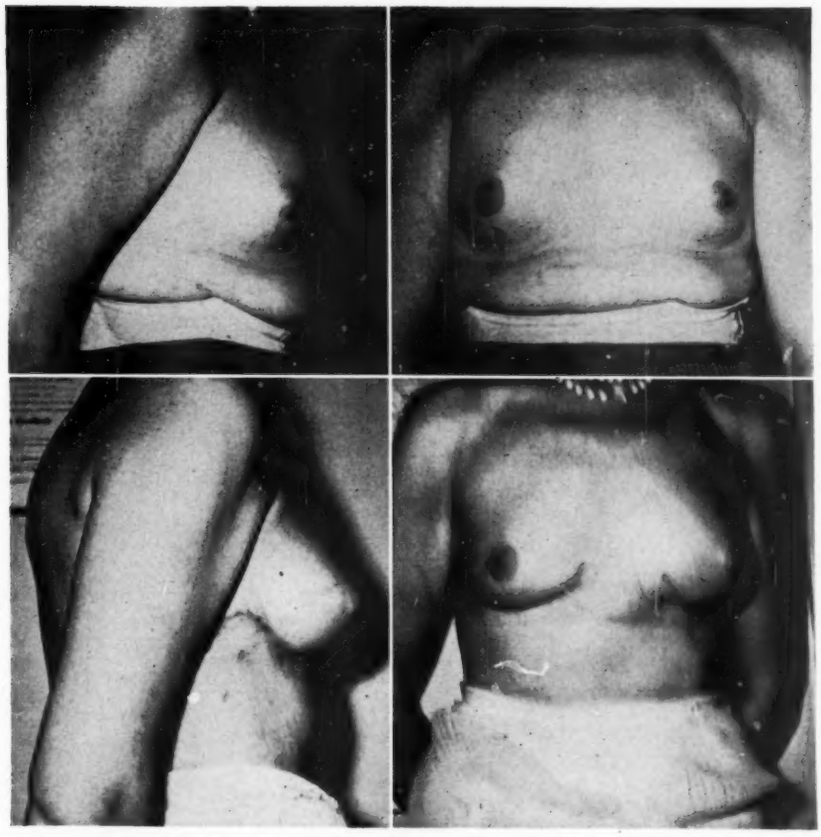
The utilization of fascia-fat-derma adjacent flap transplants, after the manner of Longacre,[2,3] has proved to be a considerably more reliable method of reconstruction of the undeveloped breast and superior to the free transplant to the submammary space of fat,[4] fat and fascia,[5] or fat and derma.[6–8] Decrease in size due to shrinkage and the possibility of loss due to infection are lessened by the maintenance of the blood supply to the graft. (Fig. 1.)

Occasionally, in the very thin patient on whom it is not possible to obtain sufficient fat and derma as a flap from the chest wall, we have found it necessary to augment the superior quadrant by a small free derma-fat-fascia transplant. In the less obese type patient, who necessarily has a thinner layer of fat between the fascia and derma, the anticipation of a good result is greater than in the more obese patient because there will be less dissolution.

Technic. A crescent-shaped area of skin beneath the breast is outlined with the superior margin in the submammary fold. Bilaterally the epidermis is removed from this area. The inferior incision is extended through the corium, and superiorly the incision through the corium, fat and underlying fascia except for a central attachment approximately 7 cm. in length. We have then inferiorly undermined to the margin of the thoracic cage and mobilized the fat and fascia to swing upward in continuity with the derma-fat-fascia flap previously outlined. After elevating the breast tissue from the chest wall by blunt dissection, these flaps are attached to one another centrally and to the chest wall. The inferior skin and fat is then attached in a superior position to the chest wall and the margins approximated. Centrally, a drain is left in place for three days. If the flap does not provide sufficient tissue to give the desired bulk, the elliptic-shaped free derma-fat-fascia transplant is inserted superiorly by the use of three pull-out sutures which are removed after the closure has been completed and just prior to the application of the elastoplast pressure dressing.

RECONSTRUCTION FOLLOWING SIMPLE MASTECTOMY

Because of mastodynia and the reported increase in the incidence of carcinoma in the patient with severe generalized chronic cystic mastitis,[9,10] simple bilateral mastectomy may be indicated. Subsequent to simple mastectomy, an adequate new breast can be constructed by retaining the excess corium and



1A 1B 1C 1D

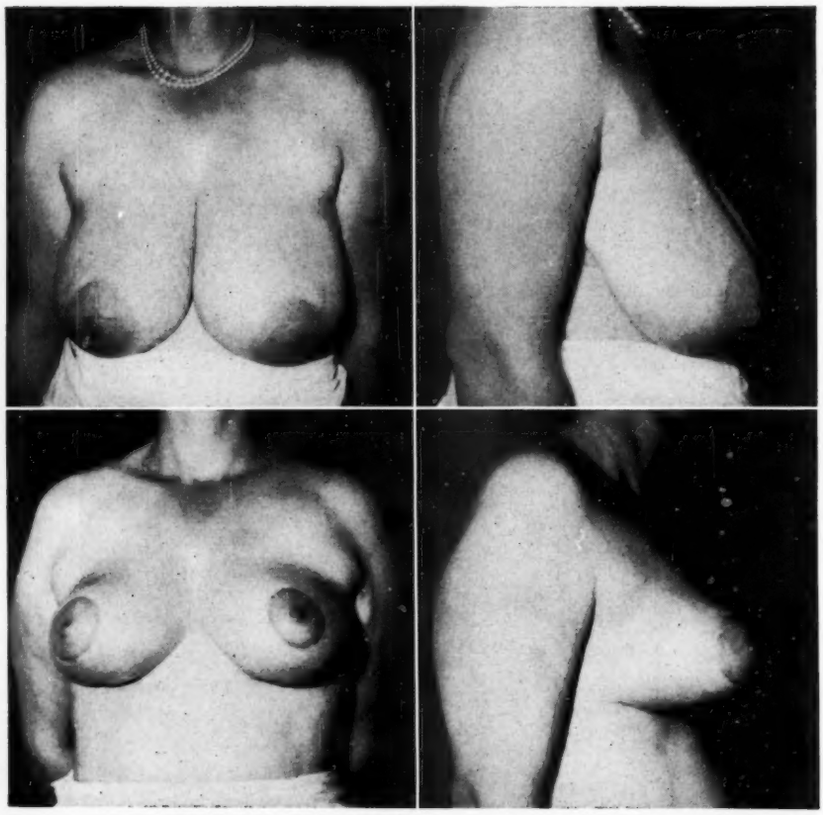
FIG. 1. Derma-fat fascia flap transplant. A and B, preoperative photographs. C and D, postoperative photographs.

fat as flaps and utilizing the principle of the preceding operation.

Technic. The new and desirable location of the nipple is scratch outlined on the breast and adequate submammary fat flaps indicated inferiorly. The epidermis is removed from the residual skin, the derma of which, with the fat, will form the bulk of the reconstructed breast rather than being discarded as in the operation for hypertrophy of the breast. The nipple is carefully dissected as a free transplant. After excision of the breast tissue bilaterally, the derma-fat-fascia flaps are mobilized and reflected superiorly and attached to the pectoral fascia over the second rib. The areola is then located in the new site from which the epidermis and part of the dermis have been removed, and the flaps closed in the usual manner. Obviously, there is more material for transplantation presented here than in the preceding type of case. However, there is the additional problem of the proper location of the nipple and the design of the submammary flaps. The criteria for the establishment of the nipple in relation to the chest wall and the length of the flap from the nipple to the submammary line is the same as in the reconstruction of the hypertrophic breast, although a little more subject to modification because of the quantity of available tissue for reconstruction.

HYPERMASTIA

In reduction of the hypertrophic breast (Fig. 2), every effort is made by most surgeons to achieve the desired results in one operative procedure, secondarily resorting to only minor modifications. Present efforts are directed toward obtaining a satisfactory simple criteria by which planning of the breast to obtain an ideal esthetic result can be outlined in advance and yet be compatible with maintaining vascularity of the tissues, particularly the areola and nipple. Some surgeons[11,12] prefer to perform free transplants of the areola, but we have reserved this for the occasional case in which the nipple is at the level of the umbilicus. Several designs for excision of the breast tissue and reconstruction have been employed.



2A 2B 2C 2D

FIG. 2. Hypertrophied breasts (nipple transposed). A and B, preoperative photographs. C and D, postoperative photographs.

Most surgeons are agreed that prior to surgery, with the patient in an upright position, the future site of the nipple should be designated and the estimated size of the breast should be calculated. We, as many others, prefer to operate with the patient in the semi-recumbent position so that the situation can be checked constantly. If the site of the nipple is outlined with the patient in the recumbent position, the nipple will tend to be too close to the clavicle and to display too much breast below the nipple. There is a tendency for surgeons to place the nipples too medially.

Various anatomic landmarks (Fig. 3) have been utilized and methods of calculation devised by plastic surgeons, and it is of interest to note the wide variation in suggested ideal locations. Some of this discrepancy is due to various experiences with regard to the necessary allowance to be made for postoperative tissue readjustment due to gravity. A brief résumé of some of these methods is pertinent.

Sebileau[13] utilized the axillary line and placed the centered nipple 6 cm. below this line, and placed the submammary line 6 cm. below this. D'Artigues[14,15] and Lagarde[16] located the nipple by drawing a line from the union of the outer third and the middle two-thirds of the clavicle and perpendicular to the axillary line. On this line, fourfingerbreadths below the axillary line, the nipple site was outlined.

Aufricht[17] has a more complicated geometric method of locating the nipple site. The essentials are as follows: the distance from the lateral sternal line to the pre-axillary line closely approximates the distance from the third intercostal space to the submammary line and should be regarded as the diameter of the breast. The thickness of the breast is then measured with the patient in the recumbent position. By forming a rectangle with the long side equal to the length of the diameter and the short side of the rectangle equal to the thickness of the breast, a diagonal is drawn through two-thirds of this rectangle, and this distance is the distance the new nipple site should be from the inferior border of the third rib.

Bames[18] locates the nipple one-half the dis-

tance from the second and fifth rib interspaces. The length of the inferior flap is the distance from the nipple to a line drawn parallel to the submammary line when the breast is elevated.

Maliniac[19] locates the nipple at the intersection of a line drawn from the mid-point of the clavicle and a second line half-way between the acromion process and the olecranon. He states the nipple should be 14 to 16 cm. from the clavicle, 17 to 20 cm. from the sternal notch and 9 to 10 cm. from the mid-sternal line.

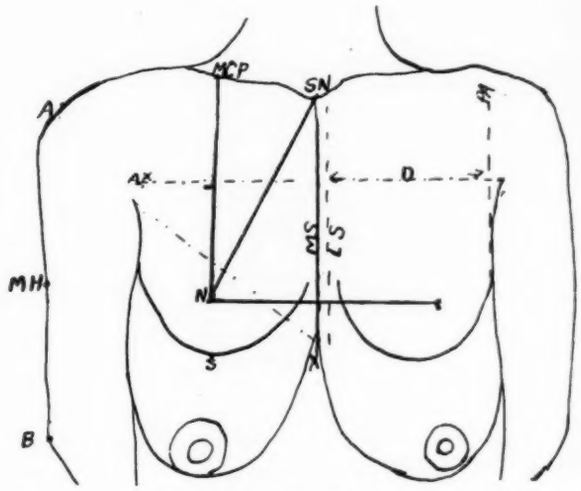


FIG. 3. Anatomic points of reference used by various authors for the establishment of the location of the nipple. A, acromion; Ax, axillary line; AxX, pectoral sternal line; B, lateral epicondyle; D, diameter at third interspace (LS-PA); LS, lateral sternal line; MCP, mid-clavicular point; MH, mid-humeral line; MS, mid-sternal point; N, nipple; PA, preaxillary line; S, submammary line; SN, sternal notch; X, xiphoid notch.

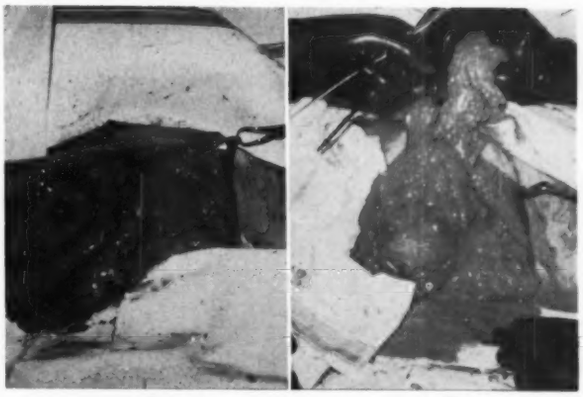


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FIG. 4A and B. Operation for hypertrophied breast. A, nipple reduced in size and skin flaps elevated. B, excision of breast tissue.

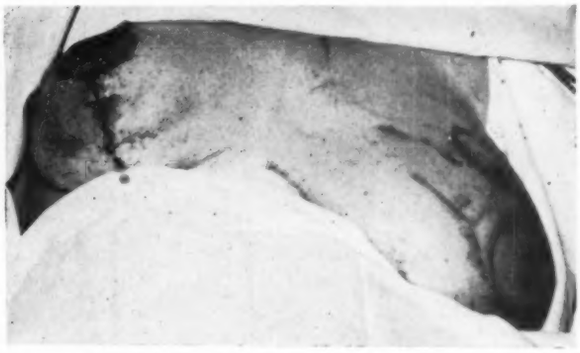
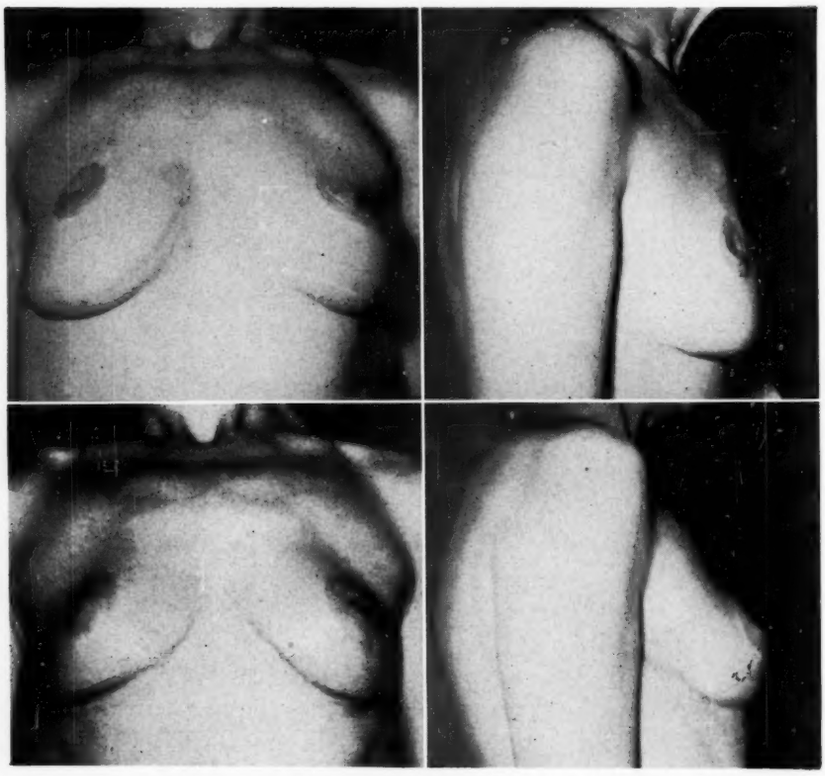


FIG. 4C. Relative size of operated and non-operated breast.

Gillies and McIndoe[20] locate the nipple 15 to 18.75 cm. (6 to 7¾ inches) from the sternal notch, 20 to 25 cm. (8 to 10 inches, usually 9 inches) from the opposite nipple, and 10 to 15 cm. (4 to 6 inches) from the "xiphoid notch." They use a large compass and describe two circles, and locate the nipple at the point of intersection. The first circle is centered on the sternal notch and has a diameter of 6 to 7½ inches, and the second is centered on the "xiphoid notch" and has a diameter of 1 inch less than the first circle.

Penn[21] prefers a more dependent breast and states that the nipple should be 20 to 21.5 cm. (8 to 8¼ inches) from the mid-clavicular point, the sternal notch and the opposite nipple. His measurements thus form a simple triangle. The inferior flap is 6.25 to 7.5 cm. (2½ to 3 inches) in length, which he considers the ideal distance from the nipple to the submammary fold.

The intercostal supply immediately beneath the nipple should be maintained by never undermining the breast in this area and taking care not to excise a wedge of tissue within 25 cm. of the areola. With due regard for these factors, one may remove a superior central wedge and inferior medial and lateral wedge of tissue from the breast without fear of nipple necrosis, if later no torsion is exerted on the residual tissue. (Fig. 4.) Such a plan of excision is utilized by us. We believe that it permits preservation of the lateral thoracic and internal mammary arteries and yet permits adequate reduction in size. Uniting the transected central portion creates more fulness superiorly and helps to decrease the width of the breast superiorly. The excision of lower wedges medially and laterally decreases the



5A 5B 5C 5D

FIG. 5. Free nipple transplant, secondary revision. A and B, preoperative photographs. C and D, postoperative photographs.

width where it is excessive; to us, this is preferable to excision of the whole upper half of the gland which is advocated by some surgeons.

SECONDARY OPERATION FOR DISPLACED NIPPLE

In free transplantation of the nipple, the increased dependency of the breast following the passage of time, postoperatively, often leads to a flat "pancake" or "bag" type breast with the nipple residing against the chest wall in a relatively superior position. (Fig. 5.) Whereas this is rather easily corrected, it does demand further surgery. The correction is made by making an incision along the submammary line. The skin and attached nipple are then elevated as a flap after being freed from the underlying tissue. The upper and lateral portions of the breast are then mobilized and transected in the superior central quadrant, and the medial sector superimposed upon the lateral to recreate a central fulness prior to reattaching the breast to the pectoral fascia superiorly. In closing, the excess skin is discarded.

GYNECOMASTIA

We have preferred to approach the problem of gynecomastia in the male through a marginal areolar incision extending approximately one-half the circumference of the areola.[22] All of the breast tissue can be adequately mobilized and excised. Only two problems, generally, are of concern: obtaining adequate hemostasis and mobilizing fat to support the nipple and prevent a later depressed appearance with scarring. When there is any doubt about complete hemostasis, we have preferred to insert a drain through a stab incision at the outer angle of the submammary fold.

LOSS OF NIPPLE

Although in some instances a split graft of a nipple[23] may be feasible, if there is total loss, probably the most reliable substitute is the transplantation of labial tissues after the manner of Adams.[24] The construction of outpouches of tissue,[25] by mobilization of adjacent tissue or tube flaps and subsequent tatooing, leaves much to be desired.

INVERTED NIPPLE

The problem of the inverted nipple is rarely attacked surgically, although Sellheim[26,27] in 1917 described an operation which has been more or less the basis for all subsequent procedures. The fundamental procedure consists of elevating the areola and nipple, everting the nipple and maintaining it in its new position by excising wedges of tissue to form a tighter base. Rapin[28] recently has modified this by excising triangles of skin around the margin of the areola in order not to place the areola under tension in closure. We have not tried the procedure and therefore cannot evaluate it.

DISTORTION FOLLOWING TRAUMA

Severe scarring of the chest wall due to a burn often leads to flattening of the breast with displacement of the nipple due to contracture. (Fig. 6.) With due regard for measurements of the other breast, especially the nipple to submammary groove, the breast can be reconstructed adequately with adjacent chest or abdominal fat and fascia. After undermining and mobilizing this tissue and reflecting it superiorly, it is inserted beneath the residual breast tissue as described previously. There should be adequate overcorrection to allow for shrinkage. After the mobilization of the fat and fascia and the release of the contracture, a skin graft will be necessary to cover the defect created. Here, as in a free areolar nipple graft, immobilization is best achieved by suturing over a stent of surgical rayon or boric ointment gauze and mechanic's waste.

Following postmastectomy radiation injury to the chest wall, a rather difficult situation is often presented, for not only is the skin often atrophic but also sometimes ulcerated and secondarily infected. Such areas, lacking an adequate blood supply, demand coverage by transference of a flap. We have generally preferred to utilize abdominal flaps to avoid deforming the remaining breast. Sauerbruch,[29] Joseph[26] and more recently Pickrel[30] and others have preferred to utilize a flap from the opposite breast to cover such a defect.[9] Certainly, for recurrent carcinoma and sarcoma this more direct plan of coverage should be given consideration.

After ill designed simple mastectomies or radical mastectomies for benign lesions, we have seen resultant infraclavicular depressions

FIG. 6. Mobilization of fat and fascia from inframammary area and skin graft to improve breast contour. Z-plasty to axilla.

and superiorly placed scars that could not be camouflaged by a prosthesis and caused the individual considerable distress. By transposing a skin flap with a tongue of fat and fascia at the distal extremity, we have been able to improve the contour of this defect and move the scar inferiorly to permit the patient to wear a décolleté gown and bathing suit without embarassment. By swinging the base of the flap medially, the anterior axillary fold can be simulated.

SOFT TISSUE NEOPLASMS OF THE CHEST WALL

Benign soft tissue tumors of the chest wall can usually be adequately excised and direct closure achieved. Due regard for Langer's lines of excision should be observed. Large hemangiomas often may necessitate skin grafting which, however, is no problem if care is taken to obtain good fixation by the use of basting sutures and the use of a tie-on bolus for pressure.

Occasionally, an arteriovenous aneurysm may be present, and one should be alert for the possible necessity of rib resection to control the situation adequately. We had an infant patient with a vascular cystic hygroma of such considerable size and depth that a special problem was presented with regard to preservation of muscles. (Fig. 7.) The tumor extended into the corium, and the preservation of the viability of the skin flaps with adequate excision of the tumor was a problem. Care was taken to place the lines of incision low posterior on the chest wall and designed not to displace

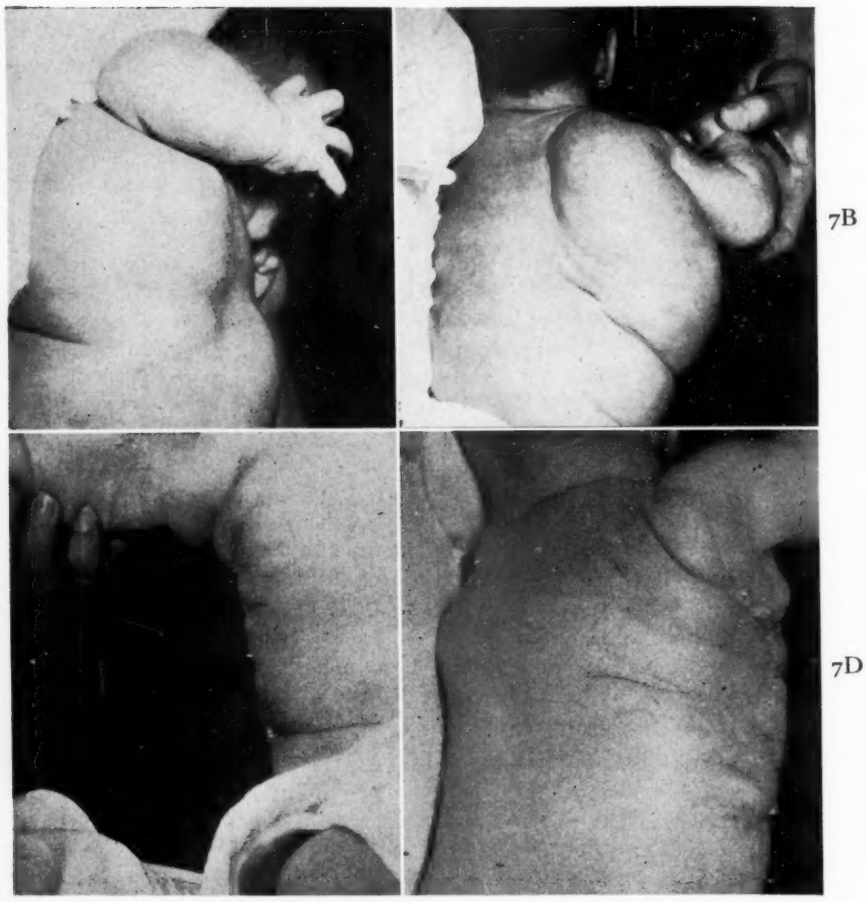


FIG. 7. Congenital vascular cystic hygroma in a three week old infant. A and B, preoperative photographs. C and D, postoperative photographs (patient at ten weeks of age).

the nipple position anteriorly. Adequate skin flaps with allowance for possible loss were outlined initially; and when a small loss occurred, complete closure could be obtained on the tenth postoperative day by revision without skin grafting.

Malignant tumors, such as squamous cell carcinoma and basal cell carcinoma, usually offer no problems. Melanomas usually demand skin grafting to obtain adequate excision.

RECONSTRUCTION OF THE BONY THORAX

A review of the literature reveals that reconstruction of chest wall defects has been a difficult problem confronting the surgeon. The motion of the thorax with respirations, coupled with the need for stability of the chest wall, makes the problem more difficult than in other regions of the body.

"Volger, in 1898, suggested a plastic operation using a bone flap from the sternum. Vulpius, in the same year, described a procedure in which strips of ribs were crossed and sutured in place with wire. The hernia repaired in this manner recurred."[32] Goodman,[33] in 1933, obtained a cure of a lung hernia by developing periosteal flaps from the superior and inferior ribs adjacent to the hernia. Winkel[34] reported the use of fascia lata in 1935. Watson and James[35] reported four cases in 1947 in which free fascia lata grafts were used.

For repair of larger defects of the chest wall with loss of bony substance due to disease, injury or wide *en bloc* resection, musculofascial flaps have been used. For anterior chest wall defects, Macmanus et al.[36] have used pectoralis major muscle flaps while Campbell[37] has combined the free fascia lata graft technic with transplantation of the latissimus dorsi muscle and obtained skin coverage with a split-thickness graft.

Sauerbruch[26] is credited with first using the

mobilized female breast for repairing such defects. Tantalum plates[38] were used for a short period, but since they are rigid foreign bodies, they loosen with respiration and ultimately become infected so that consequently their use has been largely replaced by newer substances. More recently, tantalum mesh gauze[39] and stainless steel mesh[40] have been used for this same purpose. Tantalum mesh gauze was abandoned by Effler because of its tendency to fracture or disintegrate. He and others are of the opinion that stainless steel mesh will not have this friable quality. Experimentally, stainless steel mesh gauze buried in the abdomen of rabbits does fragment. All foreign bodies implanted in the body have limited usefulness, but especially in the bony thorax are these more vulnerable.

We are in agreement with Maurer and Blades that "any defect, regardless of size, can usually be repaired by plastic procedures involving only structures which are a part of the chest wall, namely, rib, periosteum, and muscle."[32]

For small and moderate-sized lung hernias, the technic described by Maurer and Blades[32] which utilizes mobilized periosteal flaps, intercostal muscle and divided adjacent ribs is the treatment of choice.

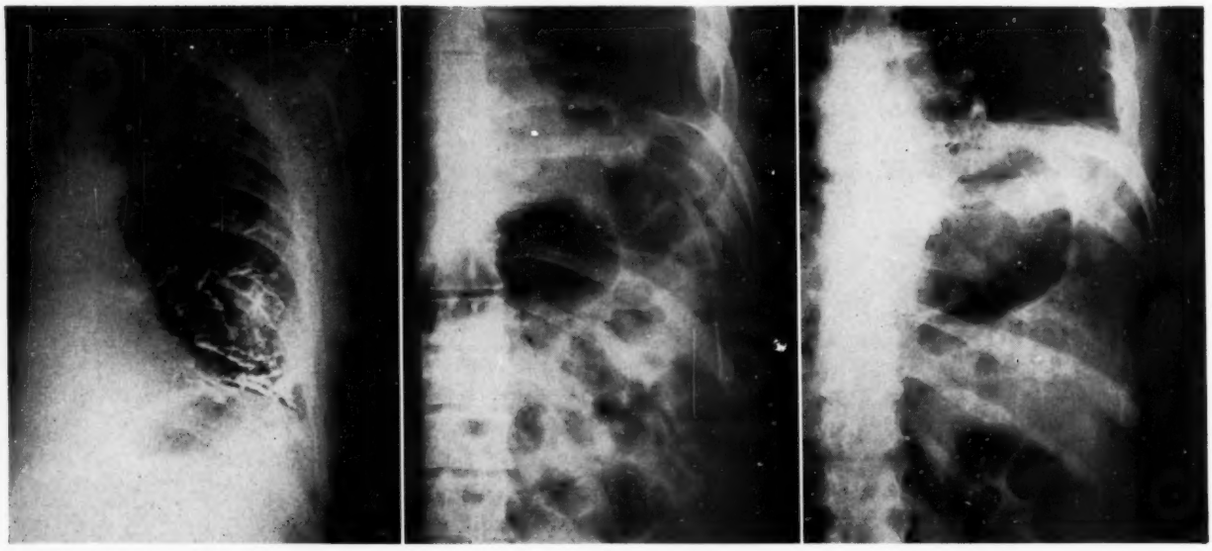
In the treatment of larger chest wall defects, including the loss of bone as caused by the adequate *en bloc* excision of large malignant tumors or trauma plus infection, we believe that bony support is important in preventing herniation and paradoxic respiration. We object to the use of foreign bodies for the reasons stated previously, and with the development of the bone bank, a ready source of material is available for suitable grafts. Pickrell et al.[30] reconstructed defects due to *en bloc* dissection using split-thickness grafts, transposed breast and direct transfer of single pedicle flap, but provided no bony support. Heaney, Cronin and Overton,[41] observing that Dailey[42] has used free rib segments in the treatment of pectus excavatum, reported on a free autogenous rib graft for repair of a chest wall defect and stated that rarely has it been employed for stabilizing the chest wall following other procedures.

We have modified the aforementioned method of using autogenous rib grafts for chest wall defects. The anterior and posterior sides of autogenous or homogenous ribs or sternum are decorticated, except at the ends of the ribs where bore holes are placed for heavy chromic sutures. It is believed that structural support is not lost, and this allows the rib to have a wider vascular contact with the underlying pleura, if present, and the overlying muscle and fascia. By the use of the Stryker saw, the transplant can be rapidly prepared by the assistant by taking off the cortex. The necessity of bony contact[43] of the graft with the host must not be overlooked and is fundamental to the success of the "take" of the graft.[44,45] We attach the rib to adjacent ribs above and below, and several such ribs may be so utilized if needed.

Case Report. The patient, a thirty-six year old white man, presented himself with the chief complaint of hemoptysis and chest deformity. Partial left lower lobectomy had been performed elsewhere for bronchiectasis. The left ninth rib was absent with operative defects in ribs eight and ten. Paradoxic motion was noted in the mid-axillary line and a large bulge was seen on coughing. The hand could be thrust into the chest, producing eructation. Bronchography revealed residual left basal bronchiectasis. The chest was entered through the left sixth rib bed and the residual left lower lobe segments were resected. The resected sixth rib was prepared for insertion as a graft as described previously. The extracostal muscles were closed over the graft. The rib is now palpable and the chest wall is stable without paradoxic motion. X-rays show the rib graft at one and twelve months. The rib graft is not as well seen at twelve months, indicating viability. (Fig. 8.)

To close the pleural defect, mobilized musculofascial pedicles can be obtained from the surrounding extracostal musculature. We can visualize the situation which would necessitate swinging such a flap of muscle beneath the rib graft except at the extremities where the graft joins the host. Massive homogenous transplants of sternum and rib have been employed successfully and we believe they are the preferable tissue for repair of large defects.

In the repair of pectus excavatum[46] a rib strut, as first used by Dailey,[42] can be tailored in the aforementioned fashion with a greater assurance of success. Unless the deformity is increasing at a rapid rate or interfering with cardiorespiratory physiology, we believe that



8A 8B 8C

FIG. 8. A, preoperative x-ray showing residual bronchiectasis, absent left ninth rib with operative defects in eighth and tenth ribs. B, x-ray one month postoperatively showing the bone graft bridging the chest wall defect. C, x-ray one year postoperatively showing presence of the bone graft less clearly, indicating viability.

FIG. 9A. Congenital absence of abdominal muscles with outflaring ribs and sternal deformity. Infant is six months old.

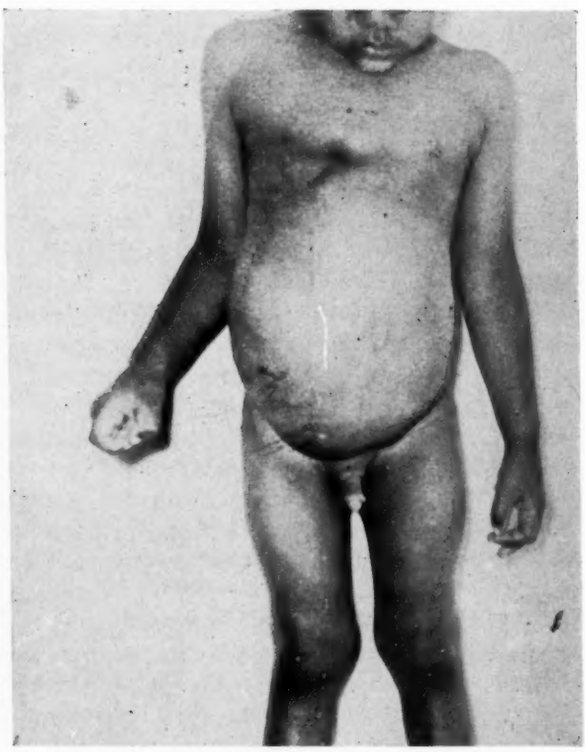


FIG. 9B. Postoperative photograph of same infant at four and a half years of age.

the repair of pectus excavatum is best performed when the patient is about four years of age. It is at approximately this age that the chest wall is rigid enough to tolerate a rib strut beneath the sternum.

Occasionally, due to congenital absence of the abdominal musculature or the inactivation of these muscles by poliomyelitis, deformity of the bony thorax may develop with the growth of the child. The use of fascial strips from the seventh rib to the iliac crest and from the sternum to the pubis,[50] as recommended by Lowman[51] in the treatment of poliomyelitis, may help to limit this change. (Fig. 9.)

SUMMARY

Commonly employed methods and the authors' modifications of these technics for the repair of breast and chest wall defects have been presented and evaluated.

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Surgery for Carcinoma of the Vulva

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SINCE 1946 the treatment of carcinoma of the vulva on the Tulane Service of the Charity Hospital at New Orleans has been surgical.[1] We have been encouraged to continue our present management by our increased survival rate as compared to that preceding the beginning of this series. Wide excision of the entire vulva and bilateral inguinal and pelvic lymphadenectomy have resulted in problems of wound management.

The disease is principally found in the older age group. Sixty-four per cent of our patients were over the age of fifty, and thirty-four per cent were over the age of sixty-five. Our youngest patient was twenty-seven. Age and physical status are not considered contraindications for surgery. If the patient does not have bony or distant metastases, surgical treatment is offered.

The operative technic, diagnostic criteria, choice of procedure, and pre- and postoperative care were set down by Conrad G. Collins, Chairman of the Department of Obstetrics and Gynecology, and followed meticulously by the team in this study. This assured a certain minimal diagnostic survey; a carefully planned pre- and postoperative regimen; a fairly standardized method of surgical attack; histologic studies of tissues removed; and frequent, thorough follow-up studies.

Employing these criteria, four patients were found to have distant or bony metastases and three refused treatment. Forty-three patients underwent surgery.

The procedure is performed in multiple stages. Vulvectomy is performed first and if indicated, as explained hereafter, bilateral inguinal and pelvic lymphadenectomy are performed at a later date either in one or two stages.

The initial diagnosis is based on histopathologic examination, dark field, and serologic and bacteriologic studies of patients with vulvar lesions. Combined and granulomatous lesions have been encountered, hence the necessity of complete studies regardless of the results of the initial diagnosis.

Vulvectomy is performed in those cases in which the biopsy specimen is reported as a non-invasive malignancy. The entire vulva is then studied by multiple sections. If no invasive areas are found, lymphadenectomy is not performed.

Vulvectomy and bilateral inguinal and pelvic lymphadenectomy are performed in those cases in which invasive malignancy is diagnosed either by histopathologic examination or in studies of the vulvar specimen.

Five cases of non-invasive carcinoma were so managed. Three patients with invasive malignancy refused gland dissection. Thus of the forty-three patients operated upon, eight underwent vulvectomy only and thirty-five underwent vulvectomy and gland resection.

There has been some question as to the necessity of bilateral gland resection in cases of carcinoma of the vulva. There is controversy as to the necessity of deep as well as superficial resections. Of the thirty-five cases, studies of the glands removed revealed involvement in nine cases (25 per cent). Four of these nine had bilateral involvement (11 per cent of thirty-five) and two of the nine had involvement of the deep nodes or 4 per cent of all cases. Such a high incidence of node involvement justifies our present attack.

Preoperative care of these patients is directed

toward control of concurrent diseases, restoration of blood volume when necessary and bowel preparation by means of antibacterials. The choice of anesthetic agent is decided after the medical and anesthesia departments have been consulted. Our preference is spinal anesthesia.

Vulvectomy is performed in the following manner: The initial incision is made in the midline of the mons over the symphysis pubis. The incision is carried laterally and posteriorly at the depth of the levator fascia. The lesion is circumvented by at least 4 cm. This is done bilaterally and the incisions meet posteriorly over the perineal body. At times resection of the anal area is necessary. The vulva is then dissected *en bloc* medially from either side until the vaginal mucosa is encountered. Superiorly the clitoris and prepuce are incorporated in the block. The urethral meatus is preserved if possible, although at times as much as the lower two-thirds of the urethra have been sacrificed due to the proximity of the lesion. The vaginal mucosa is then divided circumferentially and the block removed. The ischiorectal fossae are then cleansed by means of the suction apparatus.

The following step is considered essential for good wound healing and functional results: The vaginal mucosa and perivaginal fascia are separated from the fascia of the encompassing levator ani muscle, freely mobilizing the vaginal mucosa. This procedure facilitates closure and reduces wound tension to a minimum. The area is closed in layers with interrupted quilting cotton sutures. The first layer is the approximation of Colles' fascia to the medial edge of the levator fascia. The second layer approximates the superficial fascia of the perineum to the perivaginal fascia. The skin is sutured to the vaginal mucosa with interrupted fine chromic catgut sutures.

With the foregoing technic we have had an incidence of 81.4 per cent primary wound healing of this site. The remaining 18.6 per cent includes all cases of hematoma, seroma, dehiscence or infection. Thus of forty-three vulvectomies, thirty-five healed without incident. Cosmetic and functional results have been excellent.

Lymphadenectomy in invasive carcinoma includes excision of the lymph nodes bilaterally. These include the superficial and deep inguinals, the femorals, external and internal iliacs, Cloquet's node, the common iliacs, hypogastrics and the lower aortal and inferior vena caval nodes. Lymphadenectomy is not predicated on gross estimation of involvement. All nodes of these areas are removed whether enlarged or small, soft or hard, matted or discrete.

To accomplish this removal, an incision is made on the abdomen at the level of the umbilicus in the mid-clavicular line. This incision is extended down to the area of the junctions of the middle and lateral thirds of Poupart's ligament, curved medially to the region of the femoral canal and down the anterior medial aspect of the thigh over the femoral vessels. Block dissection of the skin and superficial tissues overlying the inguinal nodes is then performed. The incision is carried to the fascia of the external oblique muscle, to the fascia lata over the thigh, and the block of tissue removed to this depth. This block contains a segment of the saphenous vein and the superficial inguinal nodes. The femoral canal is next opened and the lymph nodes, fat and lymphatics of this area are removed by blunt and sharp dissection and by the suction apparatus. It is necessary to free these vessels completely anteriorly, posteriorly, medially and laterally, so that they are lying free for the full extent of Hunter's canal. The fascia of the femoral canal is removed. Exposure of the extraperitoneal space is accomplished by splitting the fibers of the external oblique along the course of Poupart's ligament and extending this incision vertically the full extent of the skin incision. The external inguinal ring is identified to facilitate entering the extraperitoneal space. The internal oblique muscle is incised from its attachment to the iliac crest. The transversalis is similarly freed. The major vessels are exposed; if difficulty is encountered in this exposure, Poupart's ligament is divided. The peritoneum is reflected and retracted medially; the ureter is identified and retracted medially with the peritoneum. The vessels from the lower portion of the aorta to the femoral are stripped of the lymphatics and accompanying lymph nodes. All fat encountered in this area is removed. The internal iliac (hypogastric) artery is identified and similarly stripped. The obturator nerve is identified to prevent accidental injury of this structure and the fat and lymphatics of this space are removed. The obturator node is removed, easily employing the fingers and suction tip. After the extraperi-

toneal space has been thoroughly débrided, the internal and external oblique muscles are resutured to their attachments. Drains are not ordinarily employed. Interrupted sutures of non-absorbable material are used. The skin is then closed in a similar fashion using non-absorbable sutures. Tension sutures are not utilized. The vast majority of these wounds break down in the region of Poupart's ligament where the greatest tension is noted in the repair.

This dissection of the inguinal and pelvic regions introduces four interfering factors concerned with the wound healing of these areas: (1) the removal of the tissues overlying the inguinal ligament, (2) interference with the blood supply and lymphatic drainage of the areas, (3) ease with which the area becomes contaminated and infected, and (4) postoperative lymphorrhea. Following dissection it has been our experience that in the inguinal area the wounds are always closed under tension. In a matter of a few days considerable lymphorrhea occurs with pooling of lymph in the extraperitoneal space, further lowering the resistance of this area to invading organisms. Hemostasis has not been a problem. It is believed that the accumulation of lymph and wound tension result in the high incidence of wound breakdown. Primary healing of these incisions has been the exception rather than the rule. We have not found that the use of adjacent incisions to relieve tensions of the primary incision, nor the employment of flaps, pedicles or grafts has been of much benefit. As a result these patients have wounds which either drain serum or are suppurative for long periods of time. Although this has not proved to be of serious consequence to the patient, it has required attention for periods of months and some degree of discomfort. Limitation of motion of the limbs has not resulted and ultimate cosmetic effects have been good.

Thirty-five patients with invasive carcinoma underwent bilateral inguinal and pelvic gland resections. Twenty-three of these patients had bilateral failure of primary wound healing (65.7 per cent); five patients had unilateral failure of primary healing (14.3 per cent); and seven (20 per cent) of the patients had primary healing of both inguinal incisions. Of the total seventy incisions, only nineteen (27.2 per cent) healed primarily. There was a total breakdown of fifty-one inguinal incisions (72.8 per cent).

CONCLUSIONS

The surgical management of carcinoma of the vulva can be an effective cure. Our technic is described in detail. Age, physical status and local extent of disease are not considered by us to be contraindications in the absence of bony or distant metastases. Cases of proved non-invasive malignancy are managed by wide, deep vulvectomy alone. Invasive lesions must have total vulvectomy with wide and deep excision of the vulva and bilateral inguinal and pelvic lymphadenectomy.

Functional and cosmetic results of total vulvectomy are excellent. Lymphadenectomy, while attendant with a high percentage of post-operative wound complications, is justified since a 25 per cent node involvement with invasive lesions has been found. Ultimate cosmetic and functional results following this extensive procedure are good.

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The Neglected "Free Fat Graft," Its Behavior and Clinical Use

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THE transplantation of fat first attempted by Neuber[1] in humans in 1893 was widely applied by Lexer,[2] but in recent years the procedure has been neglected. Although Lexer reported many successful applications of autogenous fat grafts to establish normal contour in hemiatrophy of the face, in small breasts and other deficiencies, present day plastic surgeons tend to use cartilage, bone or dermal grafts. This is because they believe either that the fat grafts become infected and fail to survive or that reduction in the size of fat transplants renders their clinical value negligible.

In the author's experience, free autogenous fat grafts with the overlying dermis provide the best available grafting material to substitute for soft tissue deficiencies in the cheek and breasts. In these locations dermal grafts alone do not have sufficient bulk and must be used in a number of successive operations; bone and cartilage produce hard material beneath the skin where a soft consistency is more desirable, and foreign implants give rise to marble-like structures if they are not extruded. The permanent burial of foreign implants, especially in the tissues of the breast, may also be associated with carcinogenic change in the tissues as a late result.

STRUCTURE OF FATTY TISSUE

Judging from the scarce and controversial literature and the brief account of fat in most textbooks on histology, the study of adipose tissue has been a neglected subject.

According to Fawcett,[3] during the fourth and fifth months of embryonic life *white adipose tissue* begins to develop subcutaneously in certain areas of particularly vascular mesenchymal cells called fat islands. Many small lipid droplets appear in the cytoplasm of cells which seem to be primitive fibroblasts. As the lipid droplets accumulate in the cytoplasm, the primitive fibroblast cell withdraws its processes and rounds out. The droplets enlarge and coalesce to form a single globule, which displaces the nucleus and cytoplasm to the periphery. Sections of such cells have the form of signet rings.

Multilocular or brown adipose tissue is a second type of fat, which is distinguishable from ordinary adipose tissue by its lobular gland-like appearance. This so-called brown fat is most extensively developed in hibernating animals, and for this reason it is sometimes called the hibernating gland. Brown fatty tissue having the same gross structure and microscopic appearance is also found in a number of nonhibernating animals and may occur in man. When brown adipose tissue cells in their development take on fat, it is at first deposited in fine granules, much as in fatty degeneration or as in the lipid-rich cells of the adrenal cortex. As the lipid droplets become larger, the cell takes on a moruloid or "mulberry" appearance. The nucleus, however, retains its central location and does not take on the flattened form at the periphery characteristic of ordinary signet ring adipose tissue cells. (Fig. 1.) Hibernoma, a tumor of brown fat in humans, consists of multilocular or mulberry cells with numerous droplets in the cytoplasm and a centrally located nucleus.

The fatty tissues vary in respect to firmness according to their supportive function. Kuhns[4] observes that abdominal fat cells are surrounded by a loose connective tissue stroma which serves more as a packing material than as supporting tissue for the fat cells. In special areas such as the heel, fingertip, thenar eminence and patella the fatty connective tissue serves to support the fat cells; it also contains more elastic fibers than ordinary adipose tissue,

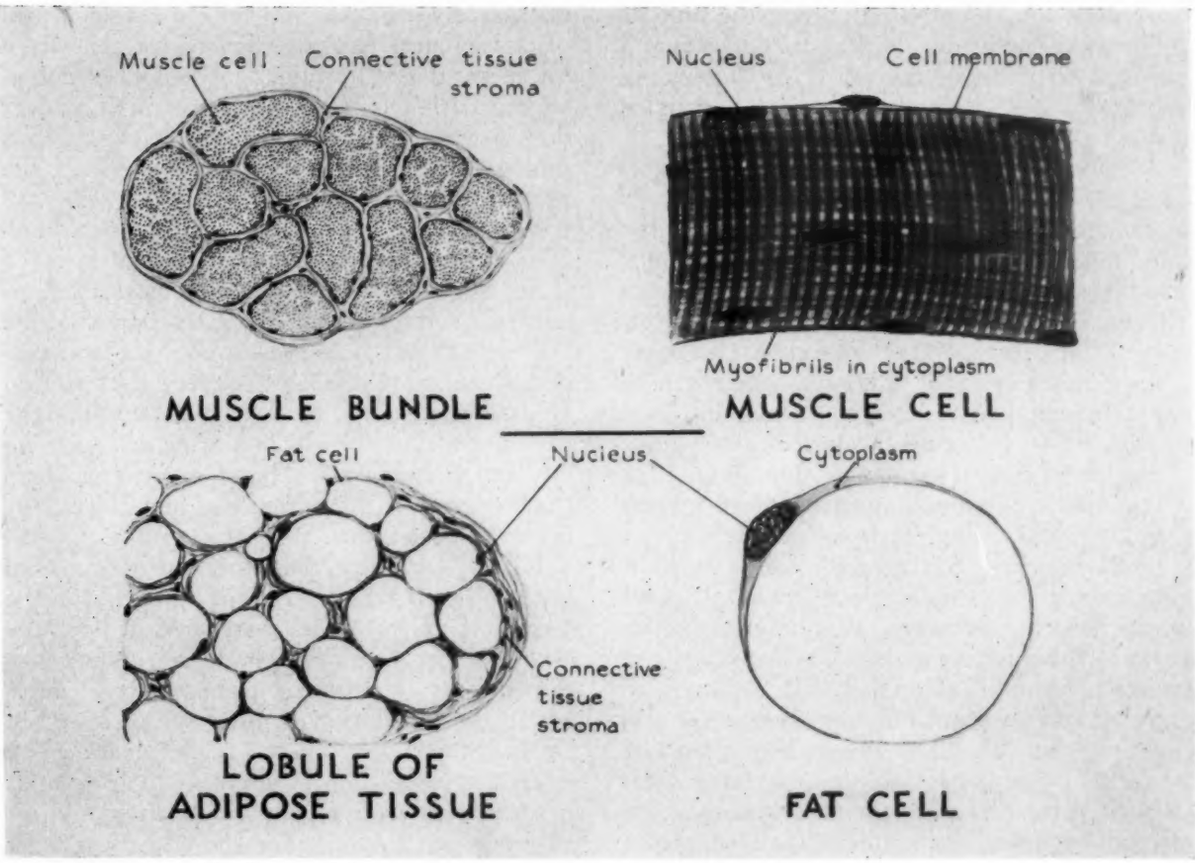


FIG. 1. Muscle and fatty tissue. These tissues are composed largely of cellular elements. They contain little inanimate intercellular material which is maintained by the activity of the muscle cells and fat cells. Thus the specific structure of muscle tissue is due to the muscle cells or fibers which contain myofibrils and sarcoplasm, and the specific structure of fatty tissue is due to the fat cell with its content of fat. Muscle and fatty tissue have a connective tissue framework which serves as a supporting structure for the muscle and fat cells. The fibroblasts in this connective tissue framework may survive transplantation when the muscle and fat cells fail to survive. The skeletal muscle cell or fibers are multinucleated, thus differing from the cells in other tissues, which have a single nucleus. Recent work has demonstrated that the fibers in skeletal muscle may extend from the origin to the insertion of the muscle. Free muscle grafts, therefore, may be similar to the axon elements of free nerve grafts in that they consist largely of segments of cells rather than of complete cell entities. The axons and the muscle cells always degenerate and disappear in free nerve and muscle grafts. Muscle and fatty tissue are derived from the mesoderm, and they contain blood vessels and nerves. (From PEER, L. A. The Transplantation of Tissues, 1st ed., p. 45. Baltimore, 1955. Williams & Wilkins Co.[16])

so that the fat resumes its shape after pressure is removed. This elastic adipose tissue is well adapted to withstand sudden impacts and prolonged pressures such as occur when an individual works with tools, stands on his heels or kneels for long periods of time. Observations have shown that this fat is spared during nutritional demands made upon other fatty depots in the body and, conversely, that it does not tend to take on large increases in obesity.

Individuality of Fatty Tissue. There are apparently conflicting viewpoints regarding the origin, replacement and activities of white adipose tissue. An early belief emphasized by Virchow in his "Cellular Pathology" was that adipose tissue is merely ordinary connective tissue in which fat has been deposited. This seems to be the view still generally held by those who have given no particular consideration to the subject, and it involves the assumption that any and all connective tissue can and does serve as a repository for fat when this accumulates in excess.

According to Wells,[5] a little reflection shows the impossibility of this conception because fat is not generally and diffusely deposited in the connective tissues throughout the body, even in obesity. For example, imagine the tragedies if the eyelids of the obese laid on the same amount of subcutaneous fat as the abdominal

wall, or if the cerebral membranes became as thick as the omentum. The hands, feet, ears and nose are seen to undergo much less thickening in obesity than the abdominal wall, thighs, buttocks and shoulders.

A demonstration of this individuality of adipose tissue is the observation that the fat cells in an abdominal skin flap transplanted to the hand take on fat when the abdominal donor site takes on a load of fat. If the patient loses abdominal fat, the transplant also gives up some of its stored fatty material. This phenomenon has been of common occurrence in our experience with pedicled abdominal flaps transferred to the hand, neck or other regions of the body. Free transplants of abdominal fat within the rectus sheath also take on fat when the abdominal donor site takes on fat.[6]

Wells believes that adipose tissue is to a large extent structurally, developmentally and functionally an independent tissue more on the order of the ductless glands. For example, the fat cell while still distended with fat may be carrying on important functions not as yet disclosed, because the mere presence of a load of fat need not seriously impair other activities. In such distended cells there are presumably just as much nuclear material and cytoplasm as there were before the fat was deposited, and these functioning elements, being outside the fat, are in immediate contact with the blood supply over a much greater area than in the fat-free cell.

Some investigators hold that the fat cell is a definite and specific type of cell formed by differentiation from mesenchymal cells that are destined to take on fat and become specialized fat cells. The fat cell is not a fibroblast, does not arise from one, and in emaciation does not revert to a fibroblast.

Regeneration of Fat Cells. Fully formed fat cells apparently do not have the power to divide, and this may be looked upon as evidence of their high degree of specialization. It is possible that an infant is born with its full complement of fat cells; these may increase in size like muscle and nerve cells, but new fat cells may not be formed in the human. It is the belief of some investigators, however, that new fat cells do develop in postnatal life through the activity of undifferentiated mesenchymal cells which take on fat and become fat cells.

The assumption that fat cells are short-lived appears to be unwarranted. Dividing fat cells are scarcely ever seen and the same may be said of dying ones. Regeneration of fat cells from undifferentiated fibroblasts is probably not of wide occurrence in the adult human (if it ever does occur). Thus when excess fatty tissue is removed from over the pubis or from the breasts in males, new formation of fat cells may not take place. The remaining fat cells, however, can take on an increased load of fat.

Fat Storage. Boeke[7] has demonstrated sympathetic nerve fibers running to individual fat cells as well as the nerve supply for blood vessels. Beznák and Hasch[8] observed that section of the nerve supply to a fat area modifies the behavior of the fat cells in storing and yielding fat, and it is therefore the sympathetic fibers that control the deposition and mobilization of fat in adipose tissue.

It has been noted that when fat is deposited in the adult it tends to be laid down first in the neighborhood of blood vessels. Moreover, the study of fat formation in living tissues has shown that it develops primarily in regions where the circulation is moderate or sluggish. On the other hand, it tends to diminish rapidly when the circulation in adjacent blood vessels becomes overactive, an observation which affords some evidence for the effectiveness of massage, exercise and the local application of heat for decreasing subcutaneous adipose tissue.[9] It is possible that the greatly increased blood supply observed in free fat grafts in six days or longer after transplantation causes removal of some of the fat in surviving fat cells in the transplant.

Grossly one notes that the subcutaneous adipose tissue in infants and young children appears more finely granular (has smaller lobules) than adipose tissue in older children and in adults. Free skin grafts applied over subcutaneous adipose tissue take completely more often in infants and young children than when similar grafts are applied in adults.

Turnover of Fat Content. Cowdry[10] observes that fat cells are not simply enduring containers with energy-rich material locked up in them at some remote period like the coal strata in a mine. Both microscopic and chemical evidence show that fat in storage is systematically changed. When single fat cells were held under observation by the Clarks,[11] they were seen to undergo cyclic changes involving accumulation of fat in small droplets, coalescence of these to form a single large droplet, subsequent decrease

in size of the droplet and beginning repetition of the process. The cycles may be relatively short in some instances (nine days) and perhaps longer in others. Schoenheimer and Rittenberg[12] have demonstrated that the larger part of dietary fat is not oxidized directly but is first deposited in the fatty tissues to replace old fat, which is removed from the fat cells and utilized.

With no change in the total amount of fat, there is nevertheless a continual replacement of the constituent fatty acids by new ones, which may be either exactly the same structurally as the displaced components or entirely different. A continual source of fatty acids is available for this dynamic metabolism of fat tissue either from food fat or by conversion of carbohydrates or proteins into fat through a process of synthesis.

It is probable that fat synthesized *de novo* from carbohydrates and proteins is constant for a given animal.[13] Food fat, however, may be deposited in fat cells in a modified chemical form. This chemical composition varies, within narrow limits, depending upon the kind of fat in the diet. For example, the milk fat of cows fed on a diet rich in coconut oil resembles the latter in its properties, and the fat of the Eskimo has a high iodine value and simulates blubber. Analogically, a preoperative fat-free diet for patients who are to have free adipose tissue transplants would provide fat cells with a fatty acid content that is constant for the particular patient, and fat extruded from ruptured cells in the graft might give rise to less host tissue reaction.

The author's clinical impression is that free abdominal fat grafts retain a larger proportion of their bulk in lean patients than in the obese. Perhaps fat cells with a large fat content do not survive free transplantation as well as fat cells with a small content of fat. This suggests the advisability of putting overweight patients on a reducing diet before operation.

THE BEHAVIOR OF FREE AUTOGENOUS FAT GRAFTS

Numerous investigators have stated that all of the fat cells in free autogenous transplants break down and release their fat content following transplantation. Large infiltrating host histiocytes are then assumed to take on fat and become the new fat cell population, which accounts for the presence of fat in grafts removed and examined microscopically one year or longer after transfer.

This theory of host tissue replacement of fat grafts has not been verified in rats[14] or in man.[6] In a continuing series of experiments with autogenous human fat grafts we have failed to find a single instance where host tissue histiocytes or other host cells were in the process of taking on fat and replacing fat cells in the transplants.

Experimental Observations. The author's series consists of autogenous human fat grafts removed at twenty-four-hour intervals from one to seven days in three patients, so that three grafts with the same burial time were available for comparative study. These early removals from humans were achieved by transplanting seven grafts with attached sutures extending through the incision out onto the skin surface. At daily intervals the fat grafts were removed by withdrawing the silk sutures. Fat grafts were also removed at ten, twelve, sixteen, twenty, twenty-five and thirty days, and at intervals up to fourteen months. The oldest transplant examined microscopically had remained in the cheek for thirteen years.

The author's interpretation of the cell behavior in these human fat grafts is as follows:

The usual reaction occurs in the host tissue surrounding the transplants, and circulating blood is present in small graft blood vessels in about four days after transfer. Thus blood vessels in the grafts appear to survive and early circulation is established through anastomosis between host and graft blood vessels. A later penetrating capillary ingrowth from the host vessels does occur; however, the surviving blood vessels in the graft, with viable endothelial cells, appear to constitute the main circulation. Larger graft blood vessels which become occluded by clotted blood or are collapsed may become recanalized and receive circulating blood at a later time.

The fat cells in free fat grafts retain their distinct cell outline for about twenty days and then a breakdown of some cells occurs, with extrusion of fat and the formation of cystic spaces in scattered areas of the graft. Characteristic large histiocytes are present in large numbers as well as polymorphonuclear leukocytes, eosinophils, cartwheel plasma cells and lymphocytes. The histiocytes and polymorphonuclear leukocytes appear to act as scavengers in removing free fat, but it is important to note

that histiocytes in the process of taking on fat and becoming fat cells were never observed. About one-half of the fat cells in the fat grafts retain their distinct cell outline and do not break down. The fibroblasts in the stroma between fat cells appear to remain viable in association with their collagenous fiber matrix.

After four months the histiocytes and other host tissue cells are less numerous, and in six months they have usually disappeared. In from six to eight months the graft resumes the appearance of normal adipose tissue, and the distended and congested blood vessels become less noticeable. The connective tissue capsule surrounding all fat grafts thins out with time but does not entirely disappear. Thus fat grafts tend to resemble encapsulated lipomas. Lipomas, however, are said to be spared in emaciation when the fat in other areas is depleted, but free fat grafts, conversely, react according to the behavior of the fat cells in their donor area.

Where large amounts of free fat are present which the host cells are unable to remove, encapsulation occurs and these clear spaces may be seen in areas of some grafts surrounded by normal-appearing fat cells. Naturally the cystic spaces add to the apparent bulk of the graft.

CLINICAL USE OF FREE FAT GRAFTS

The grafting of fatty tissue from one patient to another is a useless procedure. The fat cells in fresh homografts, the fibroblasts in the stroma, the endothelial cells in blood vessels and all other living elements fail to survive and the transplant is replaced by host fibrous tissue.[6] Host tissue cells do not take on fat and replace portions of the foreign fat graft, as stated in the older literature. The host connective tissue which replaces the homogenous fat graft is small in bulk and does not serve as a satisfactory substitute for the transplanted fat. Thus clinical consideration of free fat grafts is concerned with only one type of transplant, the autograft.

The successful management of autogenous fat grafts, whether for clinical use or experimental burial, is the same. The host site should be well supplied with blood vessels but all bleeding and even moderate oozing of blood must be controlled so that the bed is dry in a surgical sense. This can best be accomplished by prolonged accurate clamping of bleeding vessels and the application of adrenalin followed by thrombin. Ties with silk, catgut or other foreign materials are to be avoided except when large blood vessels are involved, and here the ligature should include only the vessel end to avoid necrosis of large portions of host tissue. The dissection should be with sharp instruments or, if possible, should follow natural lines of cleavage to prevent trauma and subsequent breakdown of tissues in the host bed. (Fig. 2.)

The fat graft is taken with a layer of dermis and the latter is exposed by removing a thin split-thickness skin graft with the dermatome and later using the split-skin graft as a covering for the defect. The exposed dermis and the required amount of underlying fat are removed by sharp scalpel dissection and the graft is immediately inserted in its bed.

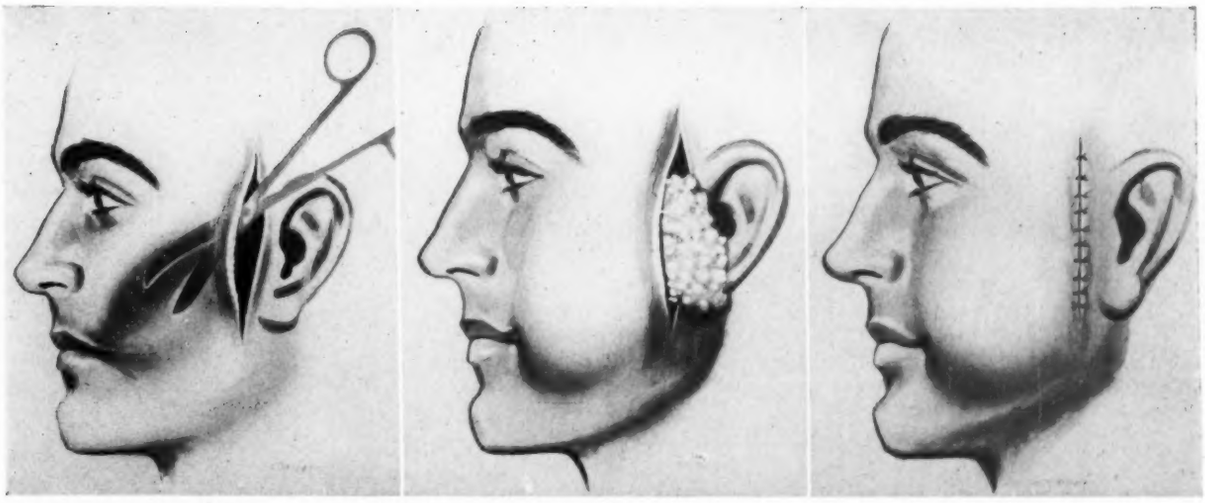
Two important considerations in removing the graft are: (1) the avoidance of unnecessary trauma and (2) the quick transfer of the fat graft to its recipient site so that it will not lose its moist covering.

In the thigh the fat may be removed with fascia lata on its deep surface and dermis on its outer surface. One hesitates, however, to remove the deep fascia over the abdominal musculature routinely because of the danger of weakening the abdominal wall.

After suture of the incision a firm but not tight supportive dressing is applied over the graft and this is left in place for one week and then reapplied for another week.

Pre- and postoperative antibiotic therapy is indicated to reduce the possibility of infection. If infection does occur early, dependent drainage should be instituted. If infection takes place, all or almost all of the graft will probably be lost. With good management, however, this should not occur often; and in locations where a soft filling substance is required, one must accept this calculated risk. If the graft does become infected and is extruded, another can be introduced when the area has healed. About 80 per cent of our fat grafts have taken satisfactorily.

Moderately large fat grafts appear to lose less bulk after transplantation than small multiple grafts. If the procedure is properly managed, massive abdominal fat grafts with attached dermis may "take" almost as well as small adipose grafts. There is a breakdown of some fat cells, however, in all free adipose grafts, and in large transplants there will be more free lipid material than in small grafts. This free fat in combination with other mate-



2A 2B 2C

FIG. 2. Free fat dermal grafts for hemiatrophy of the face. A, an incision is made in front of the auricle, and the skin and fat overlying the depression is freed by sharp scissor dissection. This incision should be in the fold between the auricle and cheek so that the scar will be inconspicuous.

B, a previously delayed fat-dermal graft removed from the lower abdominal wall is introduced into the pocket to restore normal facial contour. The graft is inserted with the fat layer next to the skin to provide a soft consistency. All recent patients have been put on a fat-reducing diet before operation and the fatty tissue and skin have been delayed about two months before operation. This delay is accomplished by making two right angle incisions down to the deep fascia and separating the fat from the fascia. The tongue of skin and fat is then sutured back into place. At the time of transfer a thin layer of skin is elevated with the Padgett dermatome from this previously delayed area aud the "conditioned" fat-dermal graft removed and transplanted into the facial pocket. The bulk of the graft restores normal contour and overcorrection is avoided.

C, the skin is sutured and a firm dressing applied for seven days, at which time the sutures are removed and another supporting dressing used for an additional week. Blood vessel anastomosis between host tissue and graft is established at approximately four days after transplantation.[6,16] By fourteen days the channels are sufficiently well established to permit removal of the supporting dressing. (From PEER, L. A.[16])

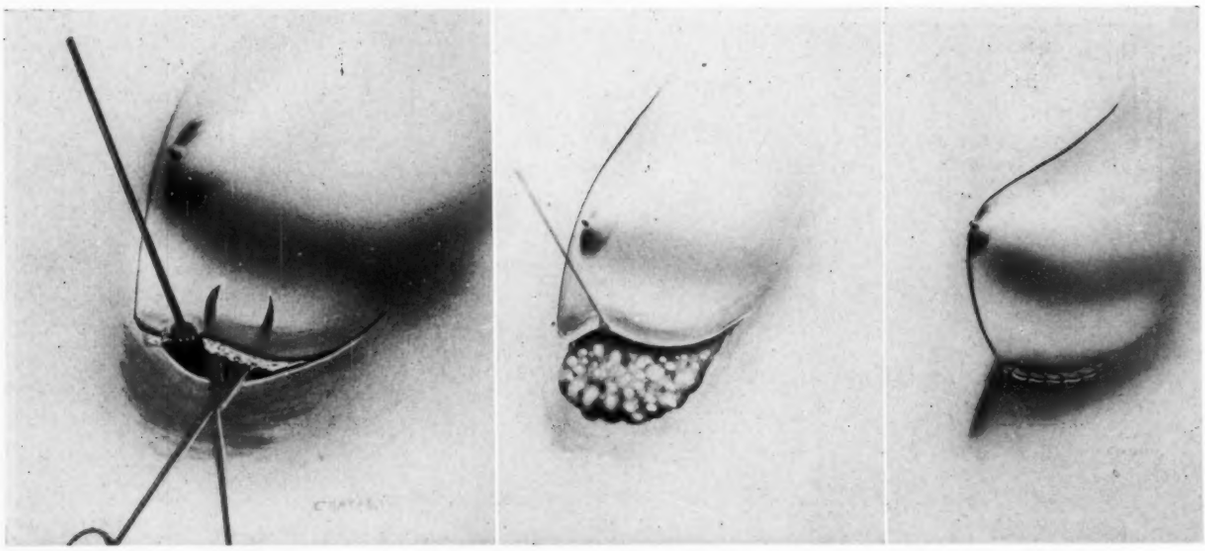
rials may become encapsulated if the host cells are unable to remove it. The author has noted cystic inclusions in large fat grafts as long as ten months after transplantation. In one such case where a second operation was performed to remove what was thought to be excess fat, a rather large amount of encapsulated fluid material was evacuated and a normal contour was established without the actual removal of any fatty tissue.

Survival of the fat cells in autografts depends upon early anastomosis between host and graft blood vessels, which has been observed as early as the fourth day after transplantation. It is therefore advisable to immobilize fat grafts for a period of two weeks to avoid injuring this newly developing circulation.

Fat is an ideal grafting material to establish normal contour in patients with hemiatrophy of the face, underdevelopment of the face associated with absence of the external ear, and in patients with lipodystrophy. Fat-dermal grafts also provide a readily available transplant for establishing normal contour in small breasts instead of foreign implants. (Fig. 3.) Lexer used free fat grafts for this purpose, and Bames[15] recently reported a series of cases in which adipose transplants taken from the buttock were utilized to establish contour in deficient breasts.

As previously stated, it appears to be advantageous to put patients on a fat-free reducing diet before operation. This insures that the patient's specific fat synthesized from carbohydrates and protein will be present in the fat cells unmodified by dietary fat. Some fat cells in all free fat grafts will break down and release their lipid content and the individual's own specific fat may be less of an irritant for host tissues than modified food fat.

A reducing diet also serves to diminish the fat content in fat cells, and this may enable the fat cells to withstand better the manipulation and surgical trauma which are unavoidable



3A 3B 3C

FIG. 3. A, an incision is made down to the deep fascia in the fold beneath the breast and a pocket is formed beneath the mammary gland.

B, a "conditioned" fat-dermal graft is inserted in the pocket to elevate the breast. All patients have been on a fat-free reducing diet before operation to diminish the storage of fat in the abdominal adipose cells. Lean fat cells appear to survive in larger numbers than adipose cells with a heavy load of fat. In the author's opinion many patients desiring to have their breasts made larger should be advised against operation. The size of breasts varies within normal or acceptable limits in different women. Neurotic individuals tend to blame their lack of integration and success to moderately small breasts rather than to their extreme introversion and self-absorption. The form of the "all-American woman" is becoming a national neurosis, and the plastic surgeon should be extremely cautious in selecting his cases. Patients with small breasts and sagging, wrinkled skin are most often benefited by operation.

C, the incision is sutured and a supporting dressing applied for a period of two weeks. The sutures are removed in one week.

during the transplantation procedure. When normal diet is resumed postoperatively, the patient's abdominal fat cells take on fat and the surviving fat cells in abdominal adipose transplants also take on increased lipid material so that the bulk of the graft is increased. Probably about one-half of the fat cells in the grafts have failed to survive but the viable cells seem to compensate for this loss by increased fat storage.

Clinically it is our impression, as expressed previously, that fat grafts in lean individuals retain more of their original bulk than similar transplants in the obese. Indeed, some of our large transplants in the cheek region lost so little bulk that secondary operations were necessary to remove excess adipose tissue in the grafts.

We are also using two-stage transfers of free fat grafts, allowing the transplant to remain *in situ* at the donor site for six to eight months and then shifting this "conditioned" adipose graft to the recipient area. Observations are not sufficient at this time to determine the clinical value of the two-stage procedure.

SUMMARY

In the author's experience, free autogenous fat grafts with overlying dermis provide the best available grafting material to substitute for soft tissue deficiencies in the cheeks and breasts where a soft, even contour is required.

There are apparently conflicting viewpoints regarding the origin, replacement and activities of white adipose tissue. Adipose tissue is regarded by some as merely ordinary connective tissue in which fat has been deposited, and by others as an independent tissue to a large extent, more on the order of the ductless glands.

The structural properties of fatty tissue, as its individuality, the regeneration of the fat cell, the storage of fat and changes in fat content, are discussed.

Free abdominal adipose grafts take on fat when the abdominal donor site takes on a load of fat. Conversely, if the patient loses abdomi-

nal fat, the transplant also gives up some of its stored fatty material.

Preoperative fat-free reducing diets are recommended for patients who are to have free abdominal fat transplantations, this being advantageous for the "take" of the graft.

All of the living cells in fresh homogenous fat grafts die after transplantation and the graft structure is replaced by host fibrous tissue. About 50 per cent of the fat cells in free autogenous fat grafts survive and these constitute the adipose cells in fat grafts in eight to twelve months following transplantation.

The new blood circulation in free autogenous fat grafts arises at about the fourth day through anastomosis between host and graft blood vessels.

Success in the take of the fat graft is conditioned by selection of the host site, considerations in the grafting procedure and certain clinical measures.

With proper management, large massive abdominal fat grafts with attached dermis may "take" almost as well as small adipose grafts.

It may be advantageous to "delay" adipose tissue before transplanting it as a free graft.

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A Method of Repair for Intranasal Encephalocele

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INTRANASAL encephaloceles or, as some prefer, encephalomeningoceles[6] are a rather infrequent type of congenital cerebral hernia characterized by a protrusion of the brain and covering membranes through a dehiscence of the skull to present externally or in the nasal cavity. Some authors,[1] however captiously, contend that in a strict sense these lesions do not represent herniations since the brain tissue, being extruded before the skull developed, was never intracranial. Some so-called nasal gliomas are doubtlessly encephaloceles which tend to become increasingly fibrotic with the passage of time. Excellent comprehensive reviews of the subject have appeared in articles by Anderson, McGillicuddy, Moore, New and Devine, and many others.

Ingraham and Swan, in a series of eighty-four congenital cerebral hernias from the Boston Children's Hospital over a twenty-year period, found sixty-three occipital, nine parietal, six frontal, five nasal and one nasopharyngeal hernia through a defect in the cribriform plate. It is thus apparent that although these herniations may occur anywhere along the midline from the sinciput to the occiput, the latter by far the most common location, they are also present at sites in the lateral fontanels. The embryologic basis for this maldevelopment of the membranous skull anlage which fails to enclose the brain or its membranes completely is unknown at present. Spina bifida and other associated anomalies may occasionally occur, as in the case reported by Stuart of a meningocele visible through a cleft palate, and Ingraham and Swan's case which was also associated with a harelip. Multiple cerebral herniations have also been very rarely observed

The congenital anterior cerebral herniations have been divided into the sincipital and basal types. The former group, obvious on external inspection, was further subdivided by von Meyer in 1890 into the nasofrontal herniations between the nasal and frontal bones, producing a midline glabellar swelling; the nasoethmoid hernias between the frontal, nasal and ethmoid bones appearing in the region of the bony and cartilaginous portions of the nose, and lastly the naso-orbital variety between the frontal, lacrimal and ethmoid bones presenting in the inner canthal region. The rarer basal hernias occur through defects of the orbital roof, foramen caecum, or cribriform plate of the ethmoid. Heineke in 1882 distinguished three types, namely the sphenopharyngeal, spheno-orbital and sphenomaxillary, depending upon whether the sac appeared in the nasopharyngeal or orbital cavities, or in the pterygopalatine fossa via the superior or inferior orbital fissures. Although these classifications have not been uniformly adopted, they are employed frequently enough to warrant their mention.

Despite the rarity of intranasal encephaloceles, their recognition is important indeed since serious sequelae may result from their inadvertent removal by snare as supposedly innocent nasal polyps, even biopsy or aspiration being fraught with hazard. Frontal meningoceles also have been clinically mistaken for mucoceles of the frontal sinus or dermoid cysts. O'Brien reported a meningocele within the middle turbinate that was perforated during ethmoidectomy, the perforation being followed by meningitis but with eventual recovery. Meningitis did not, however, occur in Fitz-Hugh's recently recorded case of a five year

FIG. 1. (*a* and *b*), Preoperative views of patient with intranasal meningocele.

old child who underwent two incomplete excisions of a nasal polypoid mass before its true nature was recognized; the encephalocele was then treated successfully with intranasal removal of the lesion followed with subsequent intracranial repair of the defect.

Suspicion should be aroused, especially with children in whom nasal polyps are rare, when a polypoid mass is discovered attached to the septum or originating from the superior recess of the nasal cavity and without lateral attachment near the ostia of the sinuses, which is characteristic of ordinary polyps. Encephaloceles may not necessarily pulsate synchronously with the brain or distend on internal jugular compression if much fibrosis is present. In the last case cited no pulsation or change in size with crying was observed.

Facial distortion, notably widening of the intra-ocular distance, may occur with frontal meningocele or intranasal encephalocele, and may simulate hypertelorism, which was classically described by Greig but is a totally unrelated congenital dysostosis of the skull. The separation of the eyes may appear greater than it actually is because of the flattening and widening of the nasal bridge, present in some cases of intranasal encephalocele.

External, endonasal, intracranial and combined approaches have been employed in the definitive management of anterior encephaloceles. Cerebrospinal rhinorrhea with the ever present threat of recurring meningitis is the chief complication of intranasal snare removal. Repair of the skull defect has generally necessitated a unilateral or bilateral frontal craniotomy[8] with closure of the dehiscence by means of a bone graft, dural flap, tantalum sheet[11] or pericranial graft with gelfoam.[®] In one of Williamson and Barelli's cases of intranasal encephalocele associated with cerebrospinal rhinorrhea they were able, without undue technical difficulties, to remove the intranasal mass *in toto* although not originally planning to do so, and no postoperative complications developed. The authors pointed out, however, that the usual practice is to remove the intranasal lesion separately.

The purpose of the present report is to indicate another possible extracranial mode of definitive surgical management of these interesting and uncommon lesions.

CASE REPORT

The patient, a girl, was first seen at the Mayo Clinic on April 24, 1942, at the age of five years because of a congenital nasal deformity. It had been noted at birth that there was a rather conspicuous widening and flattening of the nasal bridge with overlying dark bluish discoloration of the skin which disappeared spontaneously a month later. Lacrimation of both eyes often occurred together with not infrequent conjunctival discharge. Otherwise the past history was non-contributory and the general health of the child was reported as excellent. The results of physical examination were essentially negative except for marked widening of the nasal bones, and no external pulsation was demonstrable. The upper nasal chambers could not be visualized. Roentgenograms of the anterior base of the skull disclosed an "apparent defect in the midline extending to the right suggesting an expanding

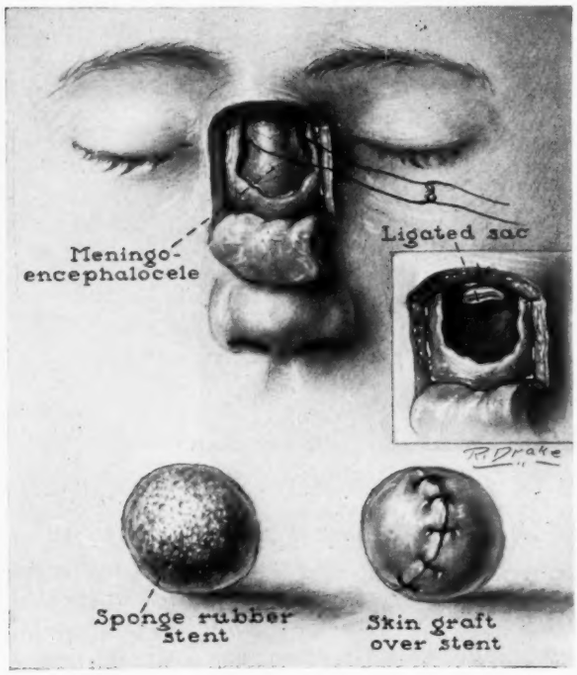

FIG. 2. Operative procedure. Above is shown the external nasal approach with the liberated neck of the meningocele just below the defect in the cranial floor. At the right the sac has been tied off and removed. Below is the sponge-rubber stent before and after its enclosure in a moderately thick split-skin graft.

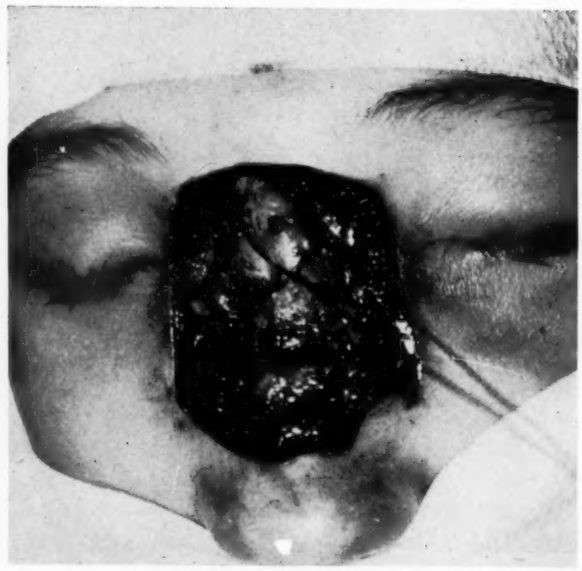

FIG. 3. Freed-up neck of the intranasal meningocele. A ligature has been passed around it.

lesion in the upper nares and fronto-ethmoid region. Has more the appearance of a meningocele than a meningioma." The results of studies of blood and urine were within normal limits, and the fundi were normal. The neurosurgical consultant recommended craniotomy for the repair of the defect but the parents were undecided because of the risk involved and returned home.

Ten years later at the age of fifteen the patient was brought back for re-evaluation largely on her continued insistence that "something be done" to correct the nasal deformity (Fig. 1*a* and *b*) about which she was becoming increasingly self-conscious. Except for left-sided epiphora and the presence of mucoid secretion expressible from the left lacrimal sac, the patient had had no interim complaints or significant illnesses—in fact, she had enjoyed robust health. Roentgenograms of the sinuses disclosed rudimentary frontal sinuses with clouding of the ethmoids on the right but basal views of the skull showed no obvious defect. The contour of the nasal bones was reported as unusual. The roentgenogram of the chest and tuberculin reaction with first strength purified protein derivative were both negative, as were the results of the other routine laboratory tests. Eye consultation revealed an alternating, non-paralytic strabismus with a tendency for the right eye to fixate. The lacrimal ducts were patent on the right but completely obstructed on the left, and the possibility of performing dacryocystorhinostomy was suggested. The neurosurgical consultant advised consultation with the plastic surgeon before deciding whether or not an intracranial procedure was necessary. Exploration of the nasal enlargement to determine its exact nature was recommended and the parents were informed of the likelihood of further plastic repair being necessary later in order to elevate the dorsum of the nose.

Operation (Fig. 2) was performed on July 8, 1953, with the patient under intratracheal anesthesia.

The mass bulging the upper part of the nose, which clinically appeared to be a meningioma, was explored through an inverted U-shaped incision extending upward along the nasobuccal folds and across the root of the nose. After the flap thus outlined had been reflected, the underlying bulging bone was removed, exposing a pulsating sac which was obviously a meningocele. The floor of the right frontal sinus was opened widely since the sinus did not communicate with the nasal fossa.

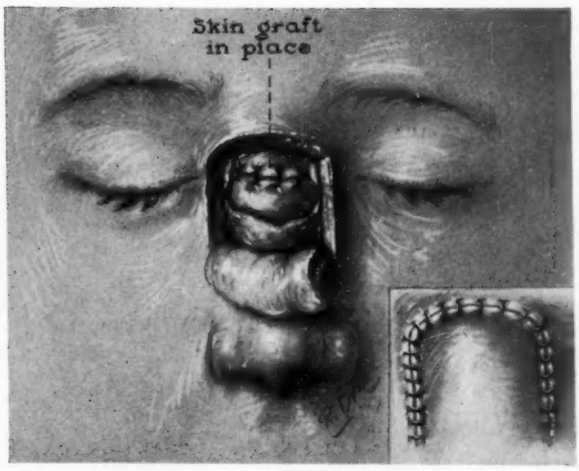

FIG. 4. The graft-covered stent has been inserted into the bony cavity previously occupied by the meningocele. This cavity did not communicate with the nasal fossae, being separated from them by an intact dense osseous wall. At the right the external nasal incision has been sutured.

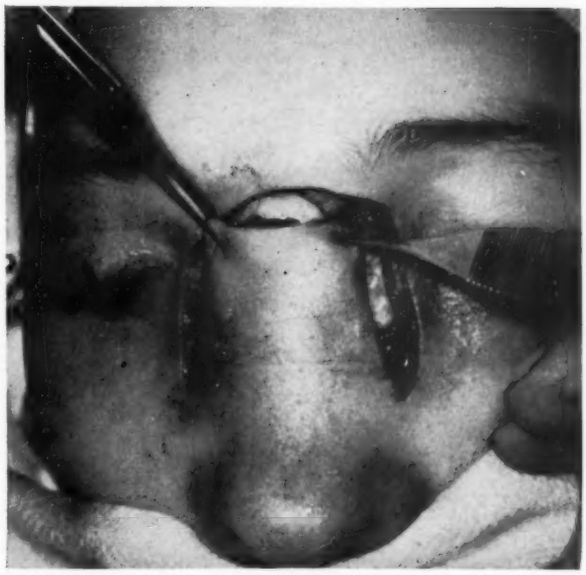

FIG. 5. Incision being closed over the skin graft inserted to line the cavity in the nose that had been occupied by the meningocele.

The thin-walled meningeal sac was dissected free (Fig. 3) down to its neck which led through a defect in the floor of the anterior cranial fossa. This defect in the base of the frontal and ethmoid bones measured a little more than 2 cm. in diameter. At this point it was noted that the bony cavity containing the meningocele did not communicate with the nasal fossae below, being separated from them by an intact dense osseous wall. The sac was perforated during the dissection and cerebrospinal fluid excaped freely. A double chromicized-catgut ligature was tied about the neck of the sac, and the sac was severed immediately below the ligature. Heterogeneous brain tissue was recognizable as the neck of the sac was severed. A thick dermatome graft from the anterior abdominal wall was then wrapped about a mold of sponge rubber with its raw surface outward. Sulfa-penicillin powder was dusted lightly into the incision, and the mold covered with the skin graft was inserted into it. (Fig. 4.) The upper portion of the skin graft was in firm contact with the ligated stump of the sac. The reflected nasal flap was then sutured back into its original position (Fig. 5), the sutures being left long and tied over the gauze dressing to insure maintenance of firm pressure on the flap and underlying graft. This was supplemented by a roller head bandage.

The postoperative course of the patient was exceedingly smooth and almost asymptomatic. She was afebrile forty-eight hours after operation and remained so until her dismissal from the hospital on the eighth postoperative day. Five hundred thousand units of neo-penil® were administered daily. Very little sedation was required since the patient was relatively free of discomfort or headaches.

On July 27th, nineteen days after the initial operation, the stent was removed with the patient under intratracheal anesthesia. (Figs. 6 and 7.)

"The upper part of the U-shaped incision was opened, the skin graft incised and the stent was removed. The skin graft had taken perfectly and there was very little accumulation of serous fluid about it. A wide opening was now made through the bony floor of the skin-graft-lined cavity into the anterior portion of both nasal fossae. The upper anterior portion of the nasal septum was removed so that a large opening, approximately 2 by 2.5 cm., extended into the nasal passages. Since difficulty was experienced in suturing the margin of the skin graft to the mucosa of the lateral wall of the nose, a large Penrose drain was inserted through either nostril up into the graft-lined cavity and a large iodoform gauze pack impregnated with petrolatum was placed alongside of these drains, the ends of the pack being brought out of the left nostril. The external wound was then closed in layers. Barring

FIG. 6. The external incision was reopened on the nineteenth postoperative day and the sponge-rubber mold was removed. There was a perfect take of the skin graft, and the defect in the cranial floor was completely closed. The bony wall that had separated the meningocele from the nasal fossae was removed widely, thus converting the spaces into a single cavity, and the external incision was resutured. Hemostats are shown inserted into the nostrils and presenting in the space previously occupied by the meningocele.

undue reaction it was anticipated the patient should secure a satisfactory result as there was no leakage of cerebrospinal fluid. The patient had not experienced any trouble with her dacryocystitis since the previous operation and on this account no attempt was made to expose the tear sac on the left in order to drain this into the graft-lined pocket."

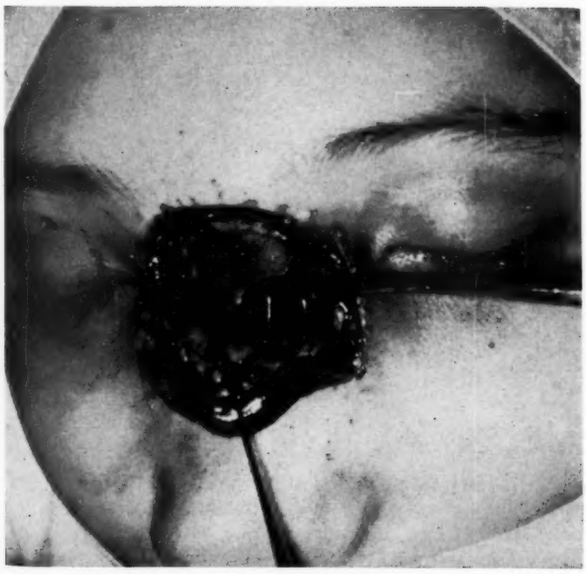

FIG. 7. Incision reopened on the nineteenth postoperative day. The skin graft–lined cavity is shown, also the tips of hemostats inserted through the nostrils.

The postoperative course was entirely uneventful. Neo-penil was again employed prophylactically. The patient was released from the hospital on the seventh postoperative day, and the Penrose drain was removed from the nose the next day. No leakage of cerebrospinal fluid was noted at any time. The patient was dismissed from the Clinic on the fifteenth postoperative day, at which time a wide opening was present on either side of the septum into the skin graft–lined cavity formerly occupied by the meningocele.

Two years following repair of the meningocele, the patient returned for consideration of

FIG. 8. (*a* and *b*), Final result following correction of nasal deformity with autogenous bone graft two years after removal of meningocele.

the external nasal deformity. She was in excellent general health and had no symptoms referable to the original condition. The postoperative scar was quite inconspicuous but the patient wished to have the moderate broadening and depression of the bridge of the nose corrected. This was effected satisfactorily by rasping down the lateral bony prominences through a small incision along the operative scar overlying the lower part of the glabella and inserting an autogenous bone graft from the crest of the ilium. The final result is shown in Figure 8*a* and *b*.

SUMMARY

A case of intranasal encephalocele in a girl aged fifteen years is presented herein. This long-standing congenital defect, with widening and flattening of the nasal bridge simulating hypertelorism, was successfully repaired via an extracranial approach. The procedure consisted of ligation and removal of the sac and lining the cavity with a skin graft. At a second operative procedure continuity was established between the nasal fossae and the skin-lined cavity that had contained the encephalocele. This method represents, it is believed, a new, or at least thus far unreported, definitive surgical approach which would appear applicable in many cases of intranasal encephalocele formerly requiring a more extensive intracranial operation, generally combined with an intranasal one to dispose of the sac. It would further seem to eliminate the hazard of cerebrospinal rhinorrhea previously associated with the strictly intranasal operation of mere ligation and amputation of the sac.

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Reconstruction of the Entire Anterior Abdominal Wall in the Presence of Postradiation Changes

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LARGE, full-thickness defects in an otherwise normal anterior abdominal wall have been successfully repaired by several methods. Farr[2] in 1922 and Lesnick[6] in 1953 used a pedicle flap of muscle and fascia for this type of repair. Gallie[3] utilized sheets and strips of fascia lata as a free graft, while Wangensteen[7] used fascia lata as a pedicle flap. Cannaday[1] popularized the use of cutis grafts and Koontz[4] described the use of tantalum mesh. However, in the presence of infection, free grafts or even pedicle grafts are relatively unsafe to use in the repair of large full-thickness defects. In circumstances in which the peritoneum cannot be mobilized sufficiently to be closed, large grafts cannot be used because of the lack of blood supply and the possibility of causing intestinal adhesions. In these two situations tantalum mesh has been used to good advantage;[5] the following case report demonstrates this point.

In the case to be described an additional hazard of extreme postradiation reaction further complicated the picture and it was necessary to remove the skin and subcutaneous tissue from the entire anterior abdominal wall. This repair required the formation of two pedicle flaps, 8 by 21 inches in size, extending from the iliac crest to the knee bilaterally. Pedicle flaps of these dimensions are seldom required in surgery, and demonstrate the teamwork between the plastic surgeon and the general surgeon in solving this reconstructive problem.

CASE REPORT

The patient, a fifty-eight year old Negro woman, first noted abdominal enlargement in 1942. In 1946 she consulted her local doctor who diagnosed a fibroid tumor of the uterus and gave her extensive x-ray therapy. The following year a painful sore developed on her abdomen; this began to drain and enlarged gradually until she came to the Robert B. Green Hospital in April, 1952.

Physical examination was essentially negative except for the abdomen. The lower abdomen protruded and presented a large ulcer about 5 by 6 inches in size, which extended through the full thickness of the abdominal wall. (Fig. 1.) The area of actinodermatitis involved the skin of the entire abdomen from the iliac crest to the opposite iliac crest, and from the symphysis pubis inferiorly to the lower rib margin superiorly. Pelvic examination revealed a large mass filling the pelvis and attached to the ulcer. The cervix was clean. Examination of cervical and endometrial biopsy specimens was negative. Intravenous pyelogram was negative except for a pelvic mass with calcification, displacing the uterus. Multiple biopsy specimens of the ulcer showed no disease. Purulent drainage from the ulcer was cultured and was found to be resistant to all known antibiotics. Chest x-rays were normal.

After considerable surgical consultation, it was believed that because of the long history, the patient had a benign pelvic tumor and a radiation ulcer with radiation changes involving the entire anterior abdominal wall.

In November, 1952, the first procedure was performed which consisted of the designing of skin flaps from the hip to the knee, 8 inches wide by 21 inches long bilaterally. (Fig. 2.) The skin and soft tissue were divided down to the fascial level; the ends of the flaps were not severed and no undermining was done. The second procedure consisted of undermining the upper third of the flap and resuturing it. At the third operation the middle third of the flap

FIG. 1. Postradiation ulcer of abdominal wall, 5 by 6 inches in full thickness, with actinodermatitis of entire abdomen.

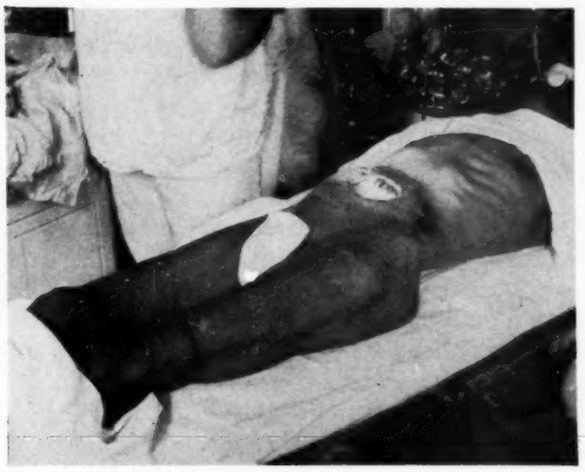

FIG. 2. Pedicle skin flaps, 8 by 21 inches in size, bilaterally.

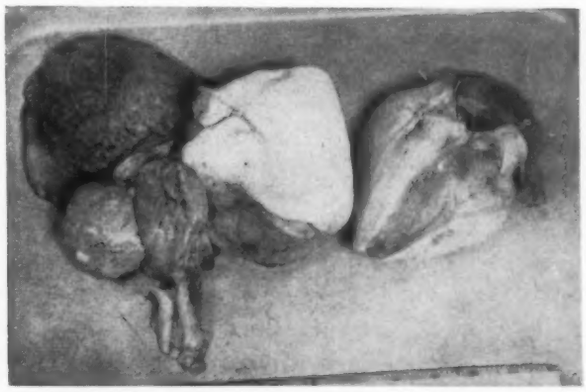

FIG. 3. Specimen shows fibroma of ovary, leiomyoma of uterus and skin of entire abdominal wall.

FIG. 4. Tantalum mesh, 6 by 8 inches in size, repaired the fascial defect. Pedicle flaps elevated.

was undermined and resutured. The fourth procedure was to undermine the distal third and resuture it. The fifth operation consisted of severing the distal end of the flaps, elevating them one-half and resuturing them. These five steps were carried out bilaterally and at approximately monthly intervals to stimulate the development of circulation at the base of the flaps. The patient had the colon prepared with terramycin® for the first, second and sixth procedures.

At the sixth and final operation there were two surgical teams: one for the abdomen, the other to elevate the two large skin flaps from the thighs. The skin and soft tissue were removed down to the fascial level from the four corners of the anterior abdominal wall to within ½ inch of the ulcer. At this point the abdominal cavity was entered in circular fashion and an area containing about 6 by 7 inches was resected but left attached to the underlying ovarian tumor. Examination of the abdomen revealed markedly few adhesions; the liver and pancreas were normal, as was the entire intestinal tract. Warm packs were placed over this tissue and hysterectomy was performed in the usual manner, as well as bilateral oophorectomy and salpingectomy. The surgical specimen is shown in Figure 3; the ovarian tumor was a fibroma. The pelvis was reperitonealized; it was impossible to mobilize the peritoneum at the site of the defect, probably because of the previous infection. A piece of tantalum mesh, 6 by 8 inches in size, was sutured over the fascial defect with interrupted No. 00 cotton sutures. (Fig. 4.)

The soft tissue of the chest wall was undermined, as was the soft tissue over the symphysis. Both of the skin flaps were placed over the abdomen, but it was found that the one

FIG. 5. Postoperative appearance of repaired abdominal wall, showing small sinus.

from the left thigh was sufficient to cover the tantalum mesh, and split-thickness grafts were placed over the remaining denuded fascial area. The flap from the right thigh was resutured in place to be used at a later date if necessary. Subcutaneous No. 00 catgut sutures and interrupted No. 000 dermalon sutures were used to close the soft tissue wounds in the skin. Split-thickness grafts were applied to the denuded left thigh and massive pressure dressings were applied to the abdomen and to both lower extremities. The patient remained in good condition throughout the operation. She had a relatively uneventful postoperative course, and the wounds healed well; however, a draining sinus developed which subsequently healed. (Fig. 5.) This was probably due to the use of cotton sutures in an infected area. She returned to work, gained 25 pounds and felt fine.

About six months postoperatively, enlarged cervical nodes developed which proved to be adenocarcinoma on microscopic examination. Repeated examinations of all types, including chest x-rays and bronchoscopy, were performed and revealed no primary lesion. The patient died seven months after her final operation, and autopsy was performed. The primary lesion, about 2 by 3 cm. in size, was located in the periphery of the middle lobe of the lung. No adhesions were found between the tantalum mesh and the intestine. One-half of the tantalum mesh was removed from the anterior abdominal wall for further study. It

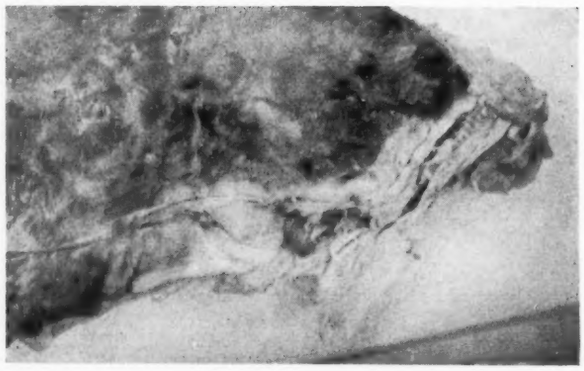

FIG. 6. Autopsy specimen of tantalum mesh.

was found that the fascia had grown into the tantalum mesh for about 1 inch around the periphery. (Fig. 6.) This fascia could not be pulled away from the mesh, but could be removed only by sharp dissection. The mesh showed no additional evidence of weakness after repeated severe tests of pulling and bending.

SUMMARY

A case report is presented, demonstrating the successful use of tantalum mesh in the repair of a large full-thickness defect of the anterior abdominal wall in an area of extensive radiation changes and gross infection. A pedicle flap from the left iliac crest to the knee was used to replace the soft tissue of the entire abdominal wall. The temporary draining sinus demonstrated that cotton sutures should not be utilized in an area of infection. A review of the material on hernia repair reveals that this case is unprecedented in the literature.

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Reconstruction of Subtotal Nasal Defects

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THE nose is as subject to the usual congenital defects, infections, new growths and trauma as are other tissues and organs of like cellular character, but due to the fact that the nose is an exposed organ in the center portion of the face it is more subject to traumatic injuries than other facial organs.

The many factors that influence the type of nasal repair to be effected make each case almost an individual problem, but the causative agents and their sequellae for partial nasal loss are so repetitious that standard procedures have been developed by plastic surgeons.

The first question that comes to mind in dealing with these problems is what has caused the subtotal nasal loss? If it is congenital, it might mean that the growth of a part has been inhibited, there is an absence or reduplication of a part, or there may be clefts or deforming rotations of existing tissue. These cases require tissue replacements in a scar-free bed. If the causative agent should be infections, this usually means that there has been considerable destruction of a section of the nose with marked central and peripheral scarring and loss of nasal lining, covering and support. If trauma is the causative agent, the extent, type and location of the injury will regulate the tissue loss. It may involve only the skin, but if severe, it will usually damage the skin and the bony and cartilaginous framework as well as the mucosa. New growths causing partial nasal loss may be benign or malignant. Under the classification of benign tumors could come the numerous cysts and congenital tumors that occur in and about the nose. Under malignant growths we are usually confronted with basal cell, basal-squamous or squamous cell carcinomas and allied tumors.

There are other new growths that occur in and about the nasal skin and the supporting structures as well as the mucosa, but these are seen so infrequently that they are problems unto themselves and dealt with as individual cases. One must consider that the type and location of the lesion, as well as the extent of tissue loss, will, of necessity, influence the type of repair to be effected. Whatever the causative agent for the tissue loss, it is axiomatic that the tissue replacement be similar, if possible, or be a tissue type of replacement that will closely resemble the lost part in function and appearance.

The age group of the affected individual influences our planning and eventual repair to a considerable degree. The congenital and infectious type of tissue losses are usually found in the young, and the amount of loss is considerable. In these patients, besides the function and appearance of the nasal replacement, one must take into account the growth factor and the time element as to when and how to do the necessary repair so that the reconstructed part will look normal when the child reaches adult life. In the older age group one is more apt to find traumatic defects as well as those from new growths. In this group also the donor areas are larger and of a greater variety.

The existing additional scars that may be present and the location of these will, of course, influence to a great degree the type of reparative surgery that may be necessary as well as the extent and location of the donor area.

Although one does not wish to be limited by too many factors as to the best cosmetic and functional repair that will eventually be effected, the economic factor is ever present and important. The character of the lesion, the sex and appearance of the individual, his type of employment and financial status, and the time available for operative repair as well as the total number of operations will all play a definite part in the type of repair that is available to the operating surgeon.

Generally speaking, defects in concealed portions of the body are corrected to obtain the maximum function of the part without too much emphasis on appearance, but due to the prominence and exposure of the nose both the functional result and cosmetic appearance are about on a par when the selection of a donor site for subtotal nasal reconstruction is considered.

There are several basic criteria that must be adhered to if one is to obtain the ultimate in subtotal nasal reconstruction. The following conditions are merely a matter of record and are not necessarily listed in their order of importance. (1) The closer the donor area, the better the cosmetic and functional result. (2) Sufficient, or an excess of, material, no matter what structure is involved, must be made available. (3) Color match and lack of hair-bearing elements of the covering material cannot be overstressed. (4) Replacement of like tissue for that involved in the defect, although not essential, is most advisable. (5) Obtaining replacement tissue with the minimum amount of visible scarring and deformity of any exposed donor areas. (6) When the inclusion, or insertion, of supportive material is needed, an adequate bed must be supplied for its reception. (7) All permanent nasal flaps that leave an exposed surface in their repair must be lined, except those covering small bony defects of the nose. Through and through defects up to ½ cm. have been successfully corrected with single covering flaps without untoward symptoms.

Immediate and direct closure takes into account all injuries in which there has been a minimal loss that can be repaired by utilizing the remaining tissue, or immediately employing contiguous flaps or cartilage grafts, free skin or composite grafts to reconstruct the defect. When there is loss or lack of tissue that has to be repaired after the initial treatments, we have to think of appropriate donor areas.

TYPES OF REPAIR AND DONOR AREAS

For the sake of completeness and simplicity these might be developed under the following headings.

Free Grafts. Split-skin grafts: When this type of material is needed for either a covering or a lining in large enough pieces the upper arm, chest or inner thigh may suffice. In these areas the skin is quite thin and hairless, particularly in the upper arm. These grafts give only a fair color match and are used most often as a lining or temporary covering unit. The chest would be a good donor area but so often one is limited in its use by the presence of hair in the male and the unsightly keloid scars that frequently occur in the female.

Full-thickness (Wolfe) grafts: These can be obtained from the following sites: The upper lid is excellent material but one is limited by the thickness of the graft and the amount of material obtainable.

Preauricular skin is also excellent material, but one is limited in these donor areas in young people. However, in older patients there is some excess and the color match is excellent. This donor area is restricted in the male because of the nearness of the beard to the tragus.

Auricular and postauricular skin as a donor site has a greater area, thicker skin and gives an excellent color match with hidden donor scars.

The supraclavicular area gives a fair amount of skin with a good color match. It is usually used in males as it is not desirable to put an unsightly scar on females in this area.

The medial aspect of the arm has abundant thin, hairless skin but is usually used only for a lining or temporary covering as the color match is poor.

The aforementioned areas are chosen for they fulfill the necessary requirements of color match, the absence of hair-bearing elements, the quantity of the donor material available and then, too, any existing scars that are left are not discernable to ordinary inspection.

Composite grafts: These grafts are used in through and through losses of soft tissue or soft tissue and cartilage. (Fig. 1.) They are limited in their size and location and frequently may require more than one application. They may consist of skin and skin, skin and fat, and skin and cartilage in varying degrees depending upon the involved area and the size of the defect. Composite grafts are obtained from the following sites: (1) Pre- and postauricular areas, utilizing both skin and fat. (2) The ear. When one wishes to obtain skin and cartilage, skin cartilage and skin, skin and fat, or skin fat and skin, the helix, concha, lobe and tragus are all available areas and, in most instances, even though relatively large amounts may be taken from the donor area, the defects can be immediately repaired. (3) The nose. The base of the

FIG. 1A. Through and through nasal loss following desiccation of carcinoma.

FIG. 1B. Composite graft of skin and cartilage used for reconstruction of nasal tip.

FIG. 2A. Carcinoma of nose of some years' standing.

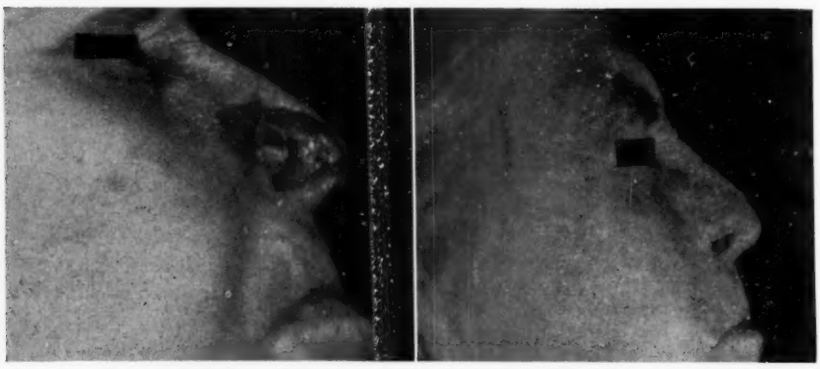
FIG. 2B. Removal of carcinoma and immediate repair with midline forehead flap.

ala or the floor of the nostril on the good side may be used as a composite graft containing both skin and subcutaneous tissue to fill in, or enlarge, the opposing nostril. (4) The distal end of the septum. When the nose is long and the recipient defect small, mucosa and cartilage are available. This donor area has been used for defects about the nostrils or for certain types of septal defects.

Flaps: These grafts have their own blood supply, are an excellent color match and are used for larger defects, but may leave behind visible scars. (Figs. 2 to 4.) This, of course, depends upon the amount of material used and the location of the donor area. They may be used singly or in pairs, for lining or covering, and as inverted or transposed flaps. One flap may perform all of these functions as well as give bulk. The following are usually the donor areas: (1) Right or left lateral and central forehead flaps, utilizing the supraorbital artery. (2) Right or left supraorbital flaps, using the same nourishing artery. (3) All manner of horizontal forehead flaps. (4) Reverse "U"-shaped and diagonal forehead flaps. (5) Varieties of the sickle flap. (6) Glabella area. (7) Dorsum

3A 3B

FIG. 3. A, x-ray dermatitis of bridge of nose with early malignancies. B, involved area removed and replaced with bilateral nasolabial flaps.



4A 4B

FIG. 4. A, large nasal defect, result of chemosurgery to right side of nose. B, reconstruction of nasal defect with single nasolabial flap folded on itself for covering and lining.

of the nose. (8) Lateral aspects of the nose. (9) The upper lid for skin replacement of lateral nasal defects. (10) Nasolabial area, either ascending or descending, wherein the graft can be used as a single covering or a lining and covering when necessary. These nasolabial flaps may be used uni- or bilaterally. More extensive nasolabial flaps, where one would utilize a rotation of the facial skin to obtain sufficient material for the nasal repair, yet leaving the donor scar in the nasolabial area, have proved effective but, as in certain of the forehead flaps, they may leave more scarring than is desired. (11) Combinations of any of the aforementioned may be used, depending upon the individual problem, but one usually gets the best functional and cosmetic repair by utilizing one large covering unit.

Other flaps and tube pedicles have been used, at times effectually, but they leave much that is to be desired such as poor color match, foreign type of skin, multiple operative procedures and all the by-products that these multiple surgical procedures entail. These grafts are obtained from the neck, chest, upper and lower arm, hand and abdomen. From their distant donor area they leave much to be desired. It is an established basic principle in plastic surgery that the closer the donor material represents the structure lost in the defect and the nearer this donor material is to the defect, the better the cosmetic and functional result will be.

Plastic Surgery of the Eyelids

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PLASTIC and reconstructive surgery of any anatomic region implies rather specialized procedures on that part. The general surgeon, however, confronted with traumatic wounds, neoplastic lesions and deformities in and around the eyelids should have knowledge about the proper methods of excision and repair in order to avoid injurious consequences. With this thought in mind, this article is written for the general surgeon rather than the specialist.

ANESTHESIA

Local anesthesia is preferable when the cooperation of the patient is desirable or necessary. The supraorbital and infraorbital nerves are blocked first. Then, to anesthetize the lids, the procaine needle is inserted at the lateral canthus and carried to the medial canthus, one for each lid. Prior to operation, several installations of a few drops of pontocaine,® nupercaine® or ophthaline will eliminate the corneal reflexes. While cocaine is a good topical anesthetic agent, it softens the cornea to such a degree that unless extreme care is exercised, the cornea may be scratched or rubbed off. Moistened cotton rolls should be used instead of gauze sponges to avoid injury to the cornea. If infiltration of procaine will distort the tissues, or when the cooperation of the patient is neither desirable nor necessary, intratracheal anesthesia is the method of choice.

INJURIES

Because of their abundant vascular supply, injuries to the eyelids are quite resistant to infection and tend to heal rapidly but with disfigurement, unless the repair is performed with the most careful coaptation of the wound margins. Wounds of the eyelids range in severity from the insignificant lacerations to complete destruction, with or without injury to the eyeball or bony orbit. Hence, all lacerations are of special significance because of possible danger or injury to these related structures. The causative factors are essentially the same as those responsible for other trauma to the face, the most common being flying glass from windshields broken in automobile accidents. While the management of eyelid injuries is governed by the same principles which apply to other trauma to the face, several "do's" and "don'ts" will be mentioned. The direction assumed by the wound is important: if a laceration is located horizontally across the lid, there will be little gaping and the resultant scar will be insignificant. However, if it divides the tarsal plate and muscle fibers vertically, great distortion of the lid and displacement of the eyelashes will occur (Figs. 1 and 2), unless the principles to be described are followed. Deformity from contracture, without appreciable loss of tissue, is usually caused by vertical scars which pull the lid out of normal alignment or cause notching of the free margins. Horizontal lacerations seldom cause contracture. Penetrating injury to the globe demands immediate and expert ophthalmologic care to preserve vision. (Fig. 3.)

In wounds of the eyelids, hemorrhage is rarely serious and can usually be controlled by direct pressure. The area is cleansed as thoroughly as possible by irrigation with normal salt solution It is far better to rely on copious irrigation rather than antiseptics, for their use may be harmful. Repeated flushing will disclose the presence of road dirt or other foreign bodies which are removed with meticulous care; any hematoma can be evacuated in the same manner. If the wound communicates with the nose or with a fracture extending into the ethmoid sinuses, the lids may become distended with air, causing pressure on the globe. A small transverse puncture wound is made to allow the air to escape.

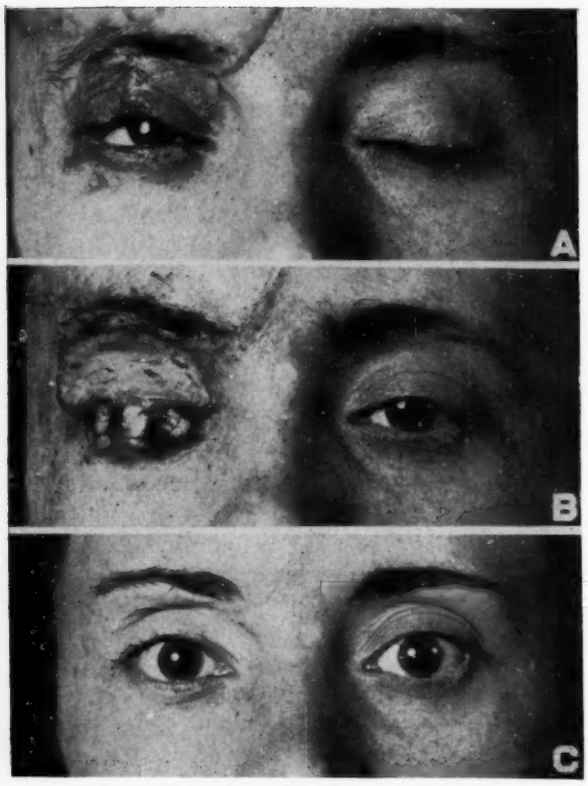

FIG. 1. A, marked ectropion due to injuries received in an auto accident. The patient was unable to close the eye to cover the globe; as a result, recurring episodes of exposure keratitis developed. The entire lid was resurfaced using a postauricular graft. Transverse darts and vents were placed in the graft to allow for drainage of blood and serum (B). The lids were immobilized by inserting mattress sutures in the margins of the tarsus which were tied over pledgets of cotton. C, postoperative photograph taken two years later.

FIG. 2. Post-traumatic ectropion and contracture of the lower lid and socket. A full-thickness graft was used to correct the ectropion. A split graft was used to enlarge the socket to accommodate a prosthetic eye.

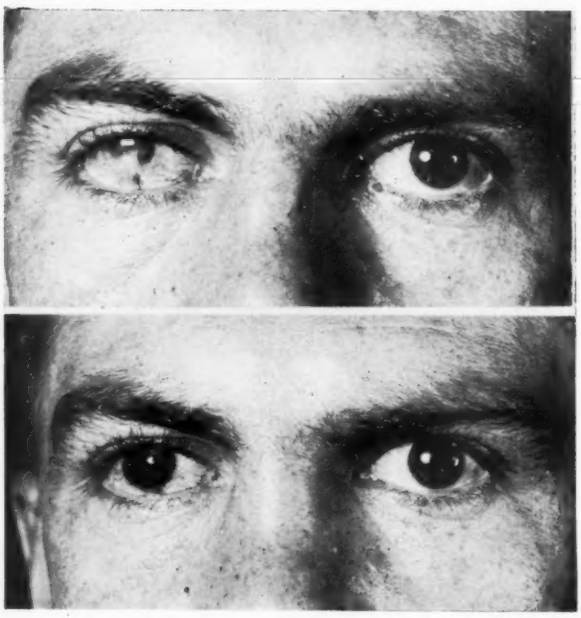

FIG. 3. Penetrating wounds of the globe demand expert ophthalmologic care to preserve vision. Dense post-traumatic scarring of the cornea and blindness resulted from a neglected penetrating injury during childhood. Even though the eye was blind and vision could not be restored, tattooing the cornea restored essentially normal appearance and may have averted serious mental sequelae.

Débridement should be performed sparingly; every fragment of viable soft tissue and skin should be preserved. The edges of the laceration are trimmed with meticulous care. In through and through tears or lacerations, the repair should be performed by either forming a flap joint or by suturing the tarsal plate on a different level and location as compared with that of the cutaneous part of the lid. Vertical lacerations should be repaired using a Z-plasty technic to avoid notching and ectopion formation. (Figs. 4 and 5.)

The method of closure in many instances will depend upon the amount of tissue which has been lost. Direct approximation of the wound margins is possible when as much as one-fourth of the total eyelid has been lost. Careful suturing will do much to obviate deformity. In wounds extending into the lid margin, the first stitch is passed through the margin, incorporating a good bite of the tarsus, and is tied in such a manner that the lid margin and cilia line of both sides will fall into their normal relations. The ends of the suture are left long and are used as a traction suture to facilitate the insertion of the remaining sutures. After this first suture has been inserted, the severed structures are united in layers from within outward.

Following closure, penicillin ophthalmic ointment is introduced into the conjunctival sac to prevent irritation of the cornea by sutures. Because of the excellent blood supply, drainage is usually not necessary; but in the case of wounds already infected, a tiny wick of gutta-

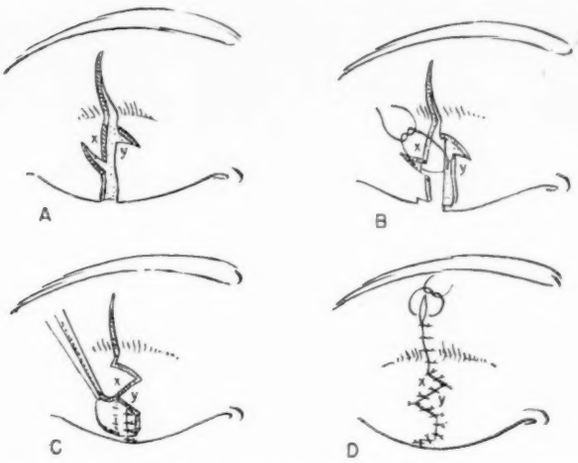

FIG. 4. Method of repair of vertical through and through laceration of eyelid. To prevent contracture and notching, the tarsal plate is repaired first by the halving and stepping method (B), using interrupted sutures of No. oooo plain catgut, with the knots tied on the skin side rather than the conjunctival side, which would irritate the globe. The Z-plasty principle is used to repair the skin. Transverse or oblique incisions, X and Y, are made to form flaps. The flaps are then switched or interpolated to form a Z or broken line so that the subsequent pulling forces are in different planes and in opposing directions.

percha is inserted near the most dependent part of the wound. A layer of petrolatum-impregnated gauze is placed over the suture line and the eyelids, and this is covered with a layer or two of small dry gauze sponges (2 by 2's), and then a layer of larger gauze sponges (4 by 4's or 4 by 8's). The dressings are held in position with cellophane or adhesive tape. If a wrap-around roller gauze dressing is used, it should be applied very loosely to prevent pressure on the glove. Xeroform® impregnated gauze should not be used, for many patients are sensitive to it; also, lacrimal secretions and xeroform will form malodorous, black, bismuth sulfide. Dressings should not be permitted to become saturated with blood or secretions, for they may become heavy and irritating. Sutures, especially those passed through the conjunctiva, should not be left in place more than four or five days.

FIG. 5. Oblique lacerations of inner third of the eyelid caused ectropion and a coloboma. Since the remaining portion of the eyelid was of good quality, the Z-plasty principle was employed. The central limb of the Z is always placed in the line of contracture. The lateral limbs are cut from the ends of the center limb, using angles of approximately 60 degrees. The flaps are then rotated to effect the final repair. While excising the scars of the forehead, the displaced eyebrow was advanced medially to its normal position.

Ectropion always implies partial destruction of the skin of the eyelid which is sufficient to produce distortion and deformity of varying degrees (Figs. 1, 2 and 5), and which may produce an exposure keratitis and ulceration of the cornea. If the deformity is not great and the remaining skin is of good quality, the employment of the Z-plasty technic is the operation of choice. (Fig. 5.) The utilization of interpolated flaps will, in many instances, obviate grafting. The principles of the Z-plasty technic[1,2] should be studied thoroughly and repeatedly. When destruction of the skin is extensive or great, free grafting of the injured lid should be performed. (Figs. 1 and 2.)

The skin of the eyelids, especially the upper lid, is delicate and thin; therefore, thin grafts should be used. Generally it is unwise to use skin from a normal lid to repair an abnormal one. If only a small graft is needed, it is usually possible to correct the condition with a Z-plasty or an alternate procedure. If a large graft is taken from an eyelid as a donor area, ectropion will result, and one has only substituted deformities at the patient's expense.

The donor sites of choice for resurfacing the lids and correcting ectropion deformity are: first, skin from the posterior surface of the ear; and second, skin from the clavicular area. Skin from these areas will quite accurately match the normal eyelids. Although full thickness grafts are used, the graft should be

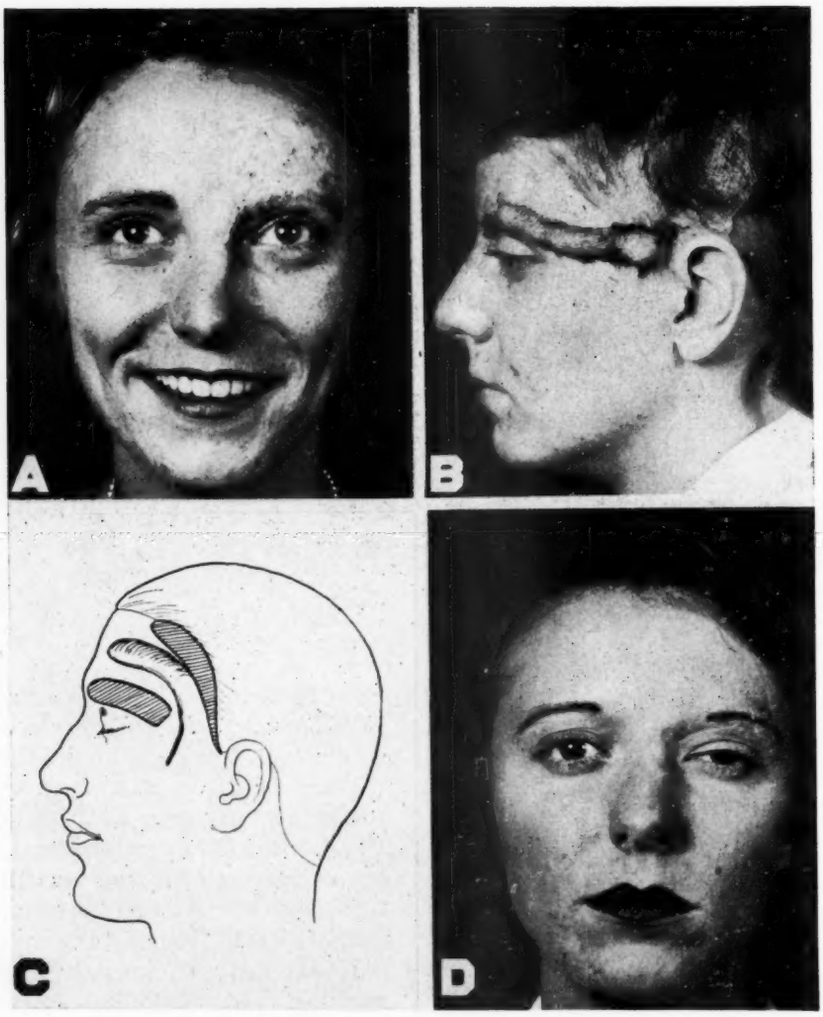

FIG. 6. A, patient received radiation to a hemangioma of the left forehead area which caused extensive postradiation changes in the skin and loss of the eyebrow. Because of the scarring, atrophy and avascularity resulting from the radiation, a hair-bearing pedicle graft from the temporal area (B,C) was used to construct the eyebrow. The left forehead area was resurfaced by advancing the right side. D, postoperative photograph taken one year later.

trimmed down so that it is actually a heavy split graft. A maneuver of help in cutting the graft is to inject the area with saline. The pattern of the graft, however, should be traced or outlined with a toothpick dipped in brilliant green before the saline is injected. Needless to say, it is unwise to cut the graft before the lid has been freed of all scar tissue and is ready to receive the graft. Grafts from the posterior ear are cut using elliptic incisions; these grafts are placed horizontally into the lid defect. Grafts from the clavicular area are cut transversely and placed in this same direction. While the texture of skin from other parts of the body (the inner aspect of the upper arm and the groin) may be of good quality, the color match and blend are unacceptably poor.

Exercising meticulous care, the pattern graft is sutured accurately into place with interrupted sutures of silk. The sutures are left uncut so they can be tied over a bolus dressing of mechanic's waste which will help to regain the normal concavity of the lid and will exert the desired tension, compression and immobilization of the grafted lid. If hemostasis is not perfect, a few transverse vents or darts may be inserted. Since the grafted lid is pulled in the direction of the graft, which may expose the cornea, the lids are approximated and immobilized by inserting mattress sutures

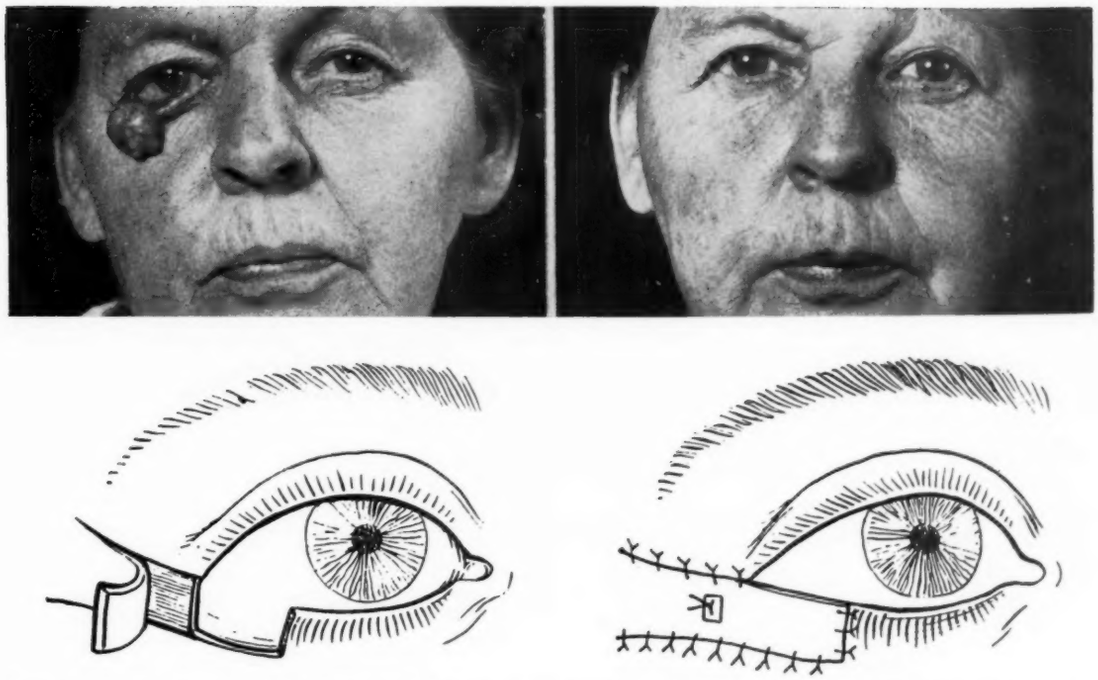

FIG. 7. Large fibroma of the lower eyelid simulating squamous cell carcinoma. The inferior surface of the tumor was ulcerated. The full thickness of the lid was resected, a sliding flap was advanced, and the global surface of the flap was lined with conjunctiva.

which are tied over a cotton pledget. (Fig. 1.) Thereafter, the graft is treated like any other skin graft.

Entropion is the opposite of ectropion, unless it is due to symblepharon and adhesions between the lid and globe, and can usually be corrected by simply excising a transverse ellipse from the lid which turns in. The inversion or turning in of the lid and the associated direction of the eyelashes will be changed to an outward direction to correct the scratching of the globe.

BENIGN TUMORS OF THE EYELIDS

For practical purposes, most tumors of the lids in children are benign. In adults, however, when approximately half of the tumors of the lid are malignant, therapy must necessarily be radical to insure complete removal. Lesions of the eyelid usually attract the early attention of the patient because of their exposed position and frequent interference with normal lid function.

Hemangiomas. These are congenital, benign tumors located anywhere on the eyelid. They may be single or isolated, or associated with extensive growth in or around the orbit. Because of their red color, these tumors are noticed early by parents when the patient is very young. *Capillary* hemangiomas consist of a bright red spot of dilated tortuous capillaries which lie superficially in the skin. Its surface may present a rough mulberry appearance from which it derives its name. The tumor is usually small and quite compressible. *Cavernous* hemangiomas consist of a deeper mass of dilated blood vessels which imparts a bluish color to the overlying skin. Not uncommonly, both afferent and efferent vessels can be seen surrounding the primary hemangioma.

While we believe that surgical excision is the procedure of choice, if surgery is contraindicated, beta radiation is applicable, for the beta rays have the same power of selective tissue destruction as do the gamma rays, but they penetrate only about 3 mm. of tissue. This is of extreme importance, for the occular lens, the eyebrows and the eyelashes are extremely sensitive to radiation. (Fig. 6.)

Nevi. These are benign congenital tumors of the lid which may or may not be pigmented. As a general rule, they are situated on the anterior margin of the lid, usually in the ciliary line, and rarely extend to the conjunctival surface of the lid. The color ranges from deep pink to brown, depending upon the amount of pig-

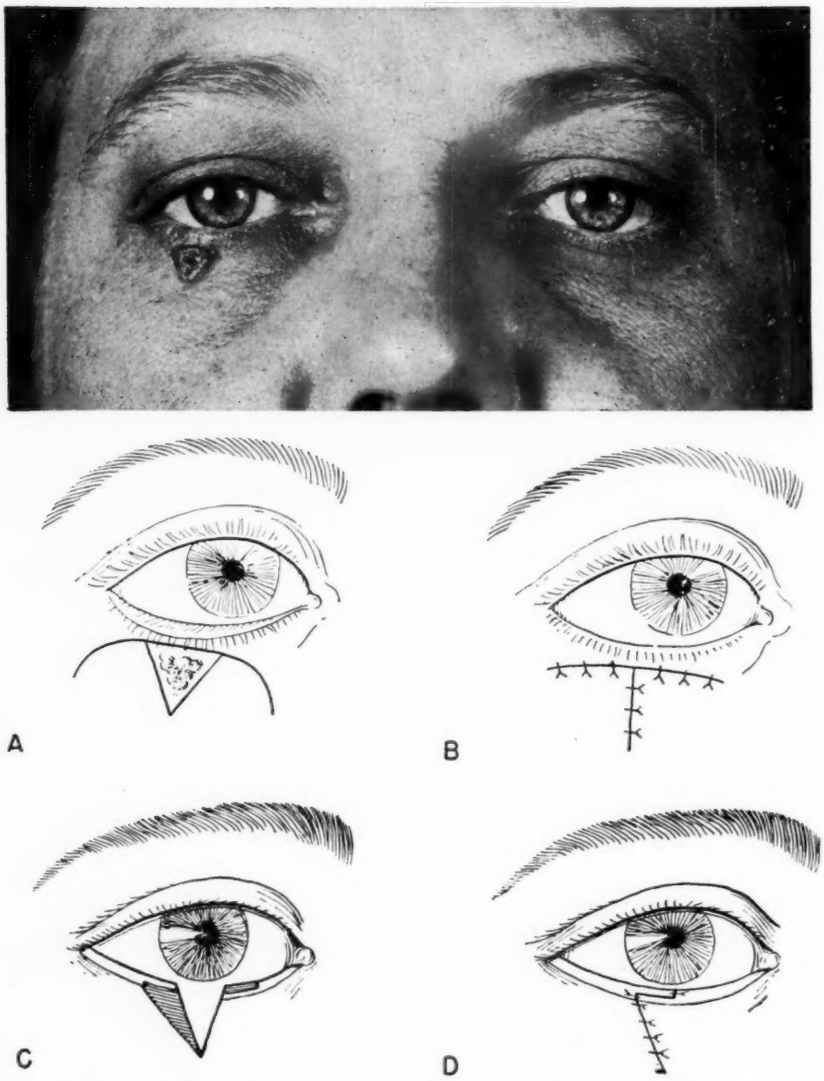

FIG. 8. Typical basal cell carcinoma of the lower lid. Wide excision is of paramount importance. If frozen sections verify that the margins and depth are free of tumor, the incisions shown in A and B are used. When in doubt about the depth, the full thickness of the lid should be resected (C). Dissection of equal portions of interior and exterior lid sections on opposite sides should be performed (C). The repair is effected by approximation and suture of the two sections on different levels (D).

ment. When found in the upper and lower lids, the nevi are usually in contact position, which attests to their congenital origin rather than to the contact itself. Nevi do not respond to radiation, and the procedure of choice is therefore surgical excision; however, the removal should be performed with meticulous care to avoid an area without cilia.

Dermoids. These congenital tumors are most frequently found in the upper lid, and they may be either on the nasal or the temporal side. They increase very slowly in size, and on some occasions have been noted to lie dormant for long periods of time. Dermoids may be either solid or cystic, are usually spherical in shape and vary in size from that of a small green pea to a marble. Dermoids do not respond to radiation and are, therefore, surgically excised.

Neurofibromas. These are also benign congenital tumors which are frequently associated with neurofibromas of other parts of the body, von Recklinghausen's disease. Café au lait spots over the torso are diagnostic when found in

association with these tumors. The temporal portion of the upper eyelid is usually first involved, becoming partially ptosed, thickened and somewhat edematous. The treatment of choice is complete surgical excision as early as possible.

Papillomas and Fibromas. These benign tumors of the eyelids are extremely common in patients in the fifth and sixth decades. The majority are located at the mucocutaneous junction. They may be single or multiple, and may show a variety of forms ranging from a flat mulberry type to a long pedunculated tumor. (Fig. 7.) Surgical excision is the procedure of choice. The specimen should be studied histologically to differentiate it from carcinoma.

Xanthomas. These benign tumors of the eyelids occur predominantly in adult women. They are pale yellow to brown in color, and project slightly above the level of the normal skin. Frequently, they are found in the neighborhood of the inner angle, and often are symmetrically placed on both upper lids.

Surgical excision is the procedure of choice. The subcutaneous tissue is infiltrated with 2 per cent procaine. The skin is stretched by finger traction, and elliptic incisions are made in a transverse direction to outline the tumor so that the skin may be closed in a transverse direction.

MALIGNANT TUMORS OF THE EYELIDS

Basal Cell Carcinomas. These tumors are almost twice as frequent as squamous cell epitheliomas. Basal cell lesions have a characteristic appearance: the edge is slightly raised and gray or bluish in color. The edge may be scalloped or annular, ulceration or umbilication is shallow, and the lesion is painless. (Fig. 8.) While most texts list basal cell epitheliomas as "only locally malignant," because the skin of the eyelids is extremely thin and supplied abundantly with lymphatics, they tend to spread primarily by direct infiltration to involve the entire lid, the conjunctiva and tarsal plate, and may soon invade the soft tissues of the orbit. Unless removed early and widely, the surgeon is faced with a major problem and the patient is faced with death.

Squamous Cell Carcinomas. These are highly malignant tumors of the lid; fortunately they are encountered less often than are basal cell carcinomas. In contrast to the basal cell carcinoma which is an umbilicated type of lesion, squamous cell carcinomas have a cauliflower-like appearance. They frequently metastasize to the regional lymph nodes at the preauricular and submaxillary regions; therefore, early surgical excision is the procedure of choice.

CONCLUSIONS

A primer on plastic surgery of the eyelids is presented for the general surgeon. Methods of repairing fresh lacerations of the lids are presented. Ways to correct post-traumatic deformities are summarized. A brief discussion of benign and malignant tumors is presented, together with methods of excision and repair.

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Burn Scar Contractures of the Axilla

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The shoulder has the greatest range of motion of any joint in the body and when the axillary skin is destroyed by an extensive third degree burn, the contracture of scar tissue following prolonged spontaneous healing usually produces severe functional disability. If third degree burns in the region of joints are allowed to heal without coverage by skin graft, most surgeons now recognize the fact that traction and splinting alone cannot prevent contractures. Arm-chest adhesions from burn scars vary widely in extent and degree, and attempts at restoration of function in this joint are partially neutralized by the effect of gravity in reducing the normal action of the weakened abductor muscles.

In reconstructive surgery three fundamental methods are available for the correction of axillary scar contractures: (1) Z-plasty procedures, (2) the rotation, advancement or interpolation of adjacent pedicle flaps, and (3) the use of free split-skin grafts. In numerous instances the best functional result will be obtained by combining two of these methods, but each procedure has its indications and value. The proper method of reconstruction can be selected judiciously for each individual case, but all patients with axillary contractures should not necessarily be submitted to one preferred method of repair. We believe that almost all burn scar contractures of the axilla can be corrected in a single operation with restoration of function, particularly abduction of the arm. An evaluation of these three basic methods of reconstruction is offered, following our observations and experiences in a series of fifty burn scar contractures of the axilla.

Davis[3] published the first important paper on this subject in 1924. He preferred the Z-plasty method with its numerous variations, and also adjacent pedicle flaps in preference to thin Thiersch grafts and the small deep grafts which often showed marked contracture after healing. At that time he concluded that any extensive contracture of the axilla could not be relieved by one operation, but usually required several stages. Of perhaps greater importance were the contributions of Brown et al.[1] who demonstrated the value of free split-skin grafts to correct contractures in one operative procedure. Koch[5] has demonstrated excellent results using the three fundamental principles of repair or a combination of these methods. Later Sutton[6] presented a series of twelve axillary contractures, all corrected satisfactorily in a single operation employing the method of interdigitated flaps, a variation of the Z-plasty procedure.

The single large Z-plasty method of reconstruction is limited to small scar web contractures or larger webs which are lightly scarred. The insufficient blood supply of large flaps of thick scar tissue will not permit wide undermining without some necrosis, and frequently this method must be supplemented by free split-skin grafts to achieve a complete correction. In one of our patients, a young Negro girl (Fig. 1), a thin, pliable scar tissue web limited abduction of the arm to less than 90 degrees. Since this scar was not thickened and was well matured, correction was achieved by a single large Z-plasty with shift of the flaps, but supplementary free split-skin graft was required to cover defects above and below.

One valuable variation of this method includes a continuous series of Z-plasties or interdigitated flaps along the line of the web. This method is limited to those axillary contractures in which enough scar tissue web is present to permit release by shifting of flaps. There is always some danger in undermining these scarred flaps, and even a partial loss will prolong convalescence greatly and may jeopardize

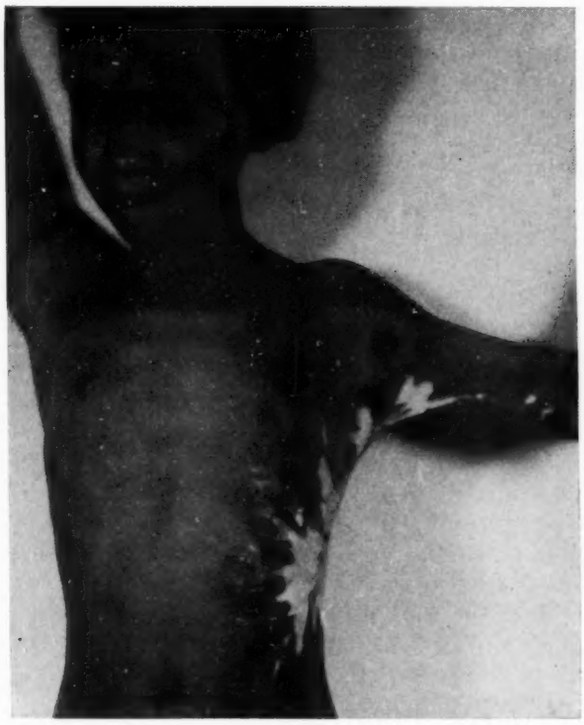
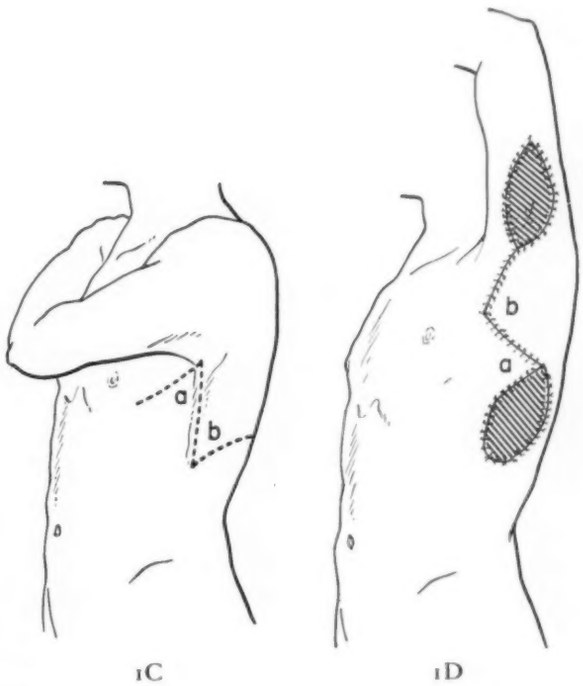


FIG. 1A. Large webbed burn contracture with depigmentation in deeper scar.

FIG. 1B. Restoration of good abduction in a single operation with large z-plasty supplemented with free skin graft.

the result. Sutton has demonstrated a wider application of this method with excellent results, but the scar should be matured and softer, the undermined scar flaps must be handled with extreme care, and the flaps cut rather wide and the sharp ends rounded off to minimize the danger of necrosis. In the patient illustrated in Figure 2A and B, the web-like axillary contracture was corrected very effectively by a series of interdigitated flaps. (Fig. 2C.) In our series of fifty axillary contractures, five cases were suitable for multiple Z-plasty release, and two were corrected by a large single Z-plasty.

In considering the second method of repair, the use of adjacent flaps, it would appear ideal to transfer a flap of normal pliable skin and fat into the apex of the axilla. This should provide the best correction, but practically, in many cases, the adjacent burn scar is so widespread that no useful flaps can be outlined for direct transfer. An adjacent flap of pliable normal skin and fat, when it is available, supplies excellent elasticity to the axilla when it is rotated or interpolated into this area. (Figs. 3A and B.) A free split-skin graft is then used to cover the



1C 1D

FIG. 1C and D. C, diagrammatic outline for single large z-plasty. D, release of contracture by shift of z-plasty flaps; many patients require free split-skin graft above and below for complete correction.

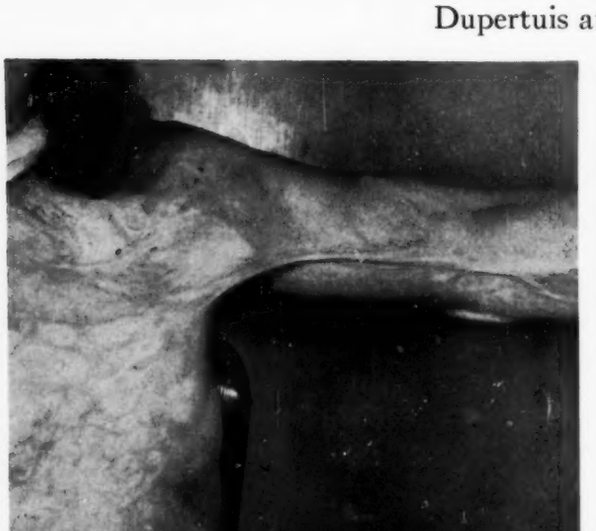


FIG. 2A. Widespread scarring with web contracture of left axilla extending down arm.

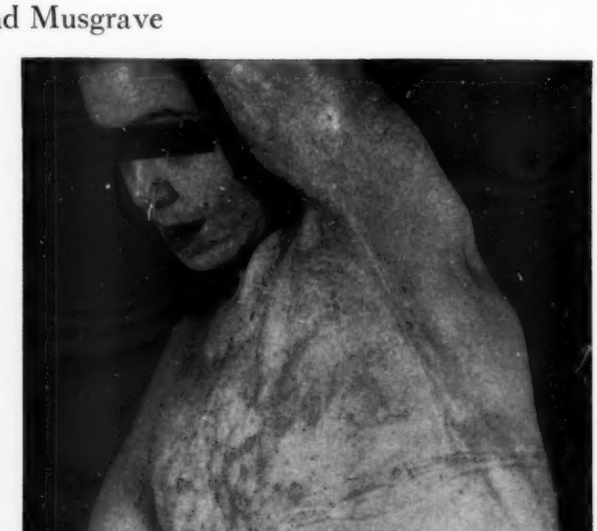


FIG. 2B. Restoration of function maintained well over a seven-year postoperative period.

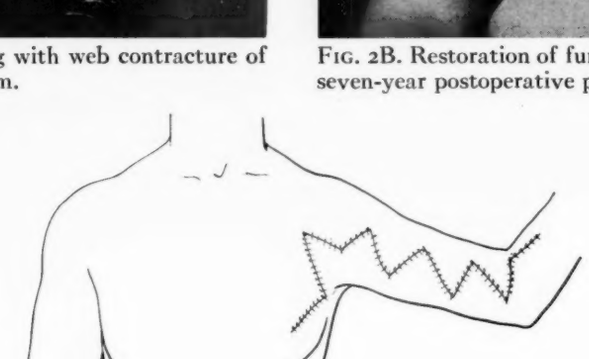
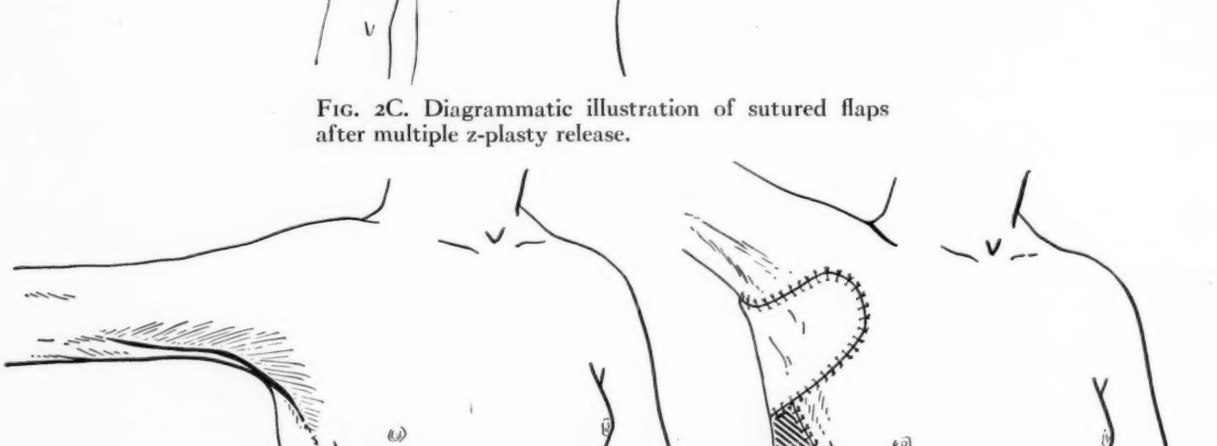


FIG. 2C. Diagrammatic illustration of sutured flaps after multiple z-plasty release.



3A 3B

FIG. 3A and B. A, drawing of adjacent flap of normal tissue outlined on chest wall. B, interpolation of flap to supply good elastic skin through axilla and split-skin graft on donor site.

FIG. 4A. Widespread burn scar with contracture of anterior axillary fold; skin in hollow of axilla normal.

FIG. 4B. Appearance two years later; restoration of complete abduction of the arm in one operation.

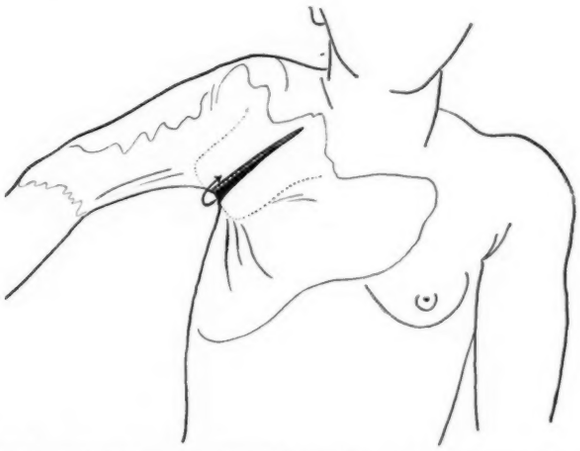


FIG. 4C. Diagrammatic illustration of incised anterior scar web with flap outlined posteriorly in normal axillary skin.

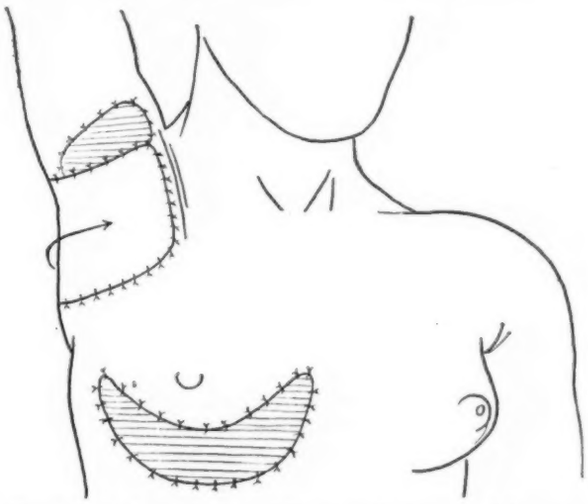


FIG. 4D. Advancement of flap to release scar tightness, with supplemental free split-skin graft on arm and below right breast.

donor site of this flap. In these fifty cases only four flaps were employed, and in each instance supplemental free split-skin grafts were required to obtain full abduction of the arm. Today there is seldom an indication to transfer large tubed pedicle flaps in stages to correct axillary burn scar contractures. There is, however, one type of case in which the advancement of a flap of normal skin and fat will provide an excellent functional result. In these

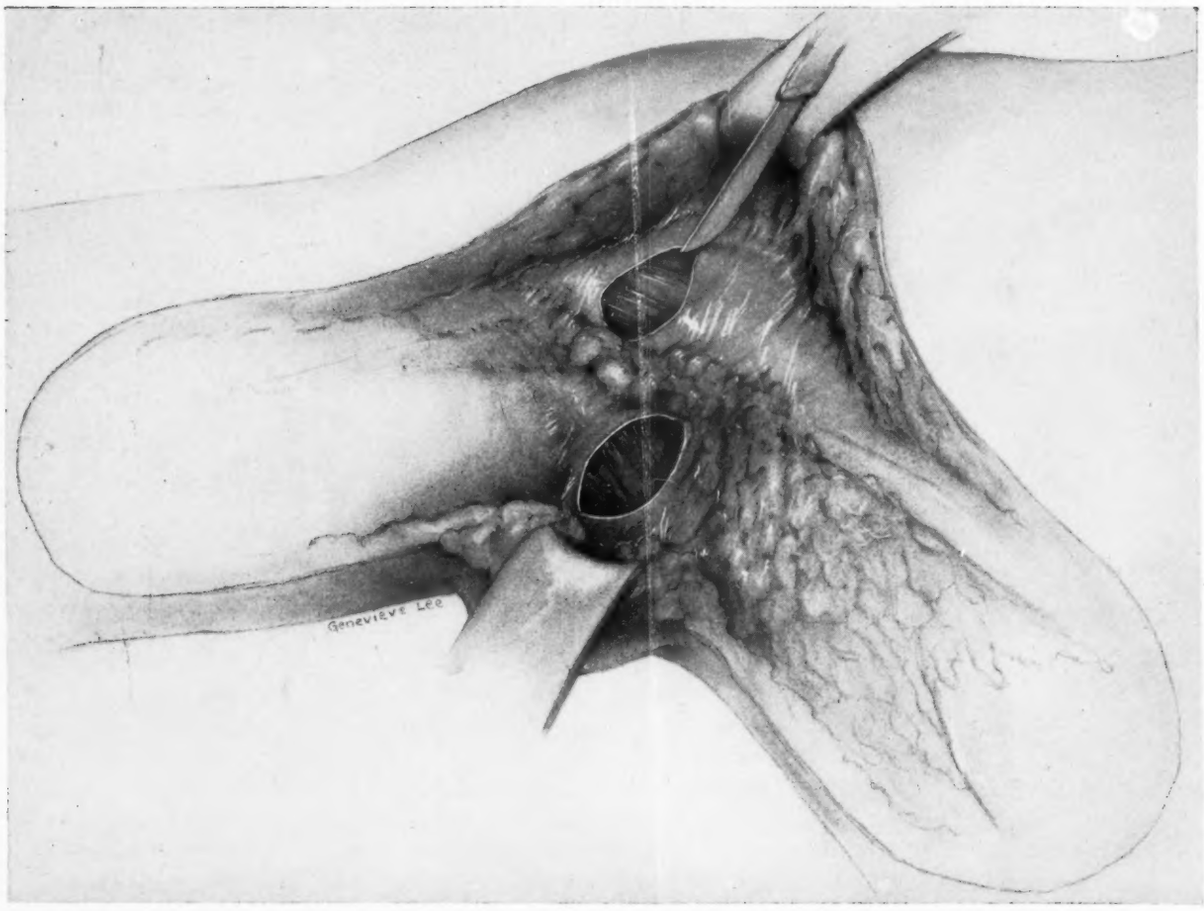


FIG. 5. Drawing to illustrate separation of tight fascia over pectoralis and latissimus dorsi muscles as arm is abducted.

cases the burn scar contracture involves only the anterior or posterior axillary fold, and the skin in the hollow of the axilla remains normal. Advancement of this flap of pliable skin releases the contracted area admirably, but the axillary hair may be shifted to a more exposed position and thus present a minor problem. It will be noted in Figure 4A that the widespread contracted scar is limited to the anterior axillary fold. When the normal skin and fat of the hollow of the axilla is undermined as a flap it can be advanced anteriorly to provide a good release of the contracture. (Fig. 4B.) It will also be noted that supplementary free graft is required above and below the flap to supply adequate release, and that the axillary hair is in a more anterior position. (Figs. 4C and D.)

Medium split-skin grafts to resurface the axilla or release adequately the tightness of scar tissue in an axillary contracture offer the most useful method available today. If we recognize that contracted scar tissue as surface covering of the axilla is usually inadequate to permit normal movements of the arm, it seems reasonable to replace and add skin to this area. Generous amounts of split-skin grafts can be obtained readily by the freehand method or the use of the dermatome and other skin-grafting implements. In a single operation it is possible to achieve complete coverage of a large defect; and since the permanent contracture of a thick-split graft is not great, function is readily restored. In recent years this method has replaced the use of large full-thickness skin grafts in most instances.

In this series of fifty cases complete correction of the axillary contracture was achieved satisfactorily by the use of free split-skin grafts in thirty-nine patients (78 per cent), and in our experience this method is the simplest, quickest and most valuable of all three. In nearly every case it has been possible to restore good abduction of the arm in one operation, but usually it is necessary to incise the tight contracted fascia

covering the pectoralis major and minor, and the latissimus dorsi muscles. (Fig. 5.) On occasion some of the fibers of these muscles are cut to allow full abduction. During the dissection of an axillary contracture it is usually not necessary to expose the axillary contents, but it has been our experience that the great nerve trunks and vessels usually are not tight or contracted as the arm is brought gradually into full abduction. In the presence of dense arm-chest adhesions existing during a growth period of several years, one may encounter tight, shortened neurovascular structures in the axilla which will not permit complete abduction in one stage, but in this series it was rare.

Complete coverage of the defect with grafts is achieved with the arm in abduction. The dressing is applied with the upper arm at approximately a right angle to the chest wall; and if the bulky dressing is held in place with elastic bandages, complete immobilization is achieved. A tie-over dressing for immobilization may be used, but frequently this is not necessary if large amounts of fluff gauze and added padding are employed. We have never found it necessary to employ a plaster cast for immobilization, since heavy casts are often uncomfortable and cumbersome and occasionally there may be movement of the grafted area beneath a rigid cast. One week after complete healing, regular massage and stretching are begun to minimize and correct the anticipated shrinkage of the grafts, always observed in the first two to three months after operation. A useful method to encourage the restoration of abduction is to have the patient lean gently against a wall on the outstretched hand, and increase the stretching by having the fingers creep slowly up the wall.

In extensive old burns it is important to excise all areas of tight dense scar in the regions adjacent to the axilla. Figure 6A illustrates an extremely tight, dense, massive scar which binds the arm to the chest wall. The satisfactory restoration of function (Fig. 6B) required four drums of split graft which have taken well and a later replacement of dense scar on the lateral aspect of the abdomen. Frequently in these thickened scar areas later malignant degeneration may occur with the appearance of a typical Marjolin ulcer. Thus, since free split-skin grafts are so easily obtained in generous quantities, larger areas of scar may be replaced

FIG. 6A. Very tight arm-chest adhesion with widespread scarring.

FIG. 6B. Four dermatome drums of split-skin graft were required to resurface defect for good restoration of function in a single operation.

quite readily to minimize the danger of carcinoma developing later and to provide the finest restoration of function in the contracted axilla.

CONCLUSIONS

1. In burn scar contractures of the axilla, our goal should be the restoration of complete abduction of the arm in a single operation when possible.

2. In certain cases the Z-plasty and interdigitated flap methods may be useful, and when available, an adjacent flap of normal skin across the apex of the axilla will provide an excellent functional result.

3. Most axillary contractures are best treated by free split-skin grafts to achieve good restoration of function in one operation. An added advantage is the elimination of adjacent dense scar where malignant degeneration may occur.

4. In this series of fifty burn scar contractures of the axilla, 14 per cent were corrected by the Z-plasty method, 8 per cent by adjacent or advanced flaps, and 78 per cent by the use of free split-skin grafts.

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Hemangiomas and Their Surgical Treatment

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INASMUCH as the various types of angiomas are among the most common congenital lesions which confront the plastic surgeon, dermatologist and radiologist, it becomes increasingly important that we recognize and outline early a definite plan and procedure for a successful end result. Complete eradication of the hemangiomas either by surgical excision or one of the various types of treatment, or a combination of these two methods, may be so planned and used that the final result will be a good functional as well as a pleasing cosmetic one. Hemangiomas may occur anywhere on the body and are present at birth or may become evident a few weeks after birth. These lesions may first appear as small telangiectatic areas on the skin measuring approximately ⅛ inch in diameter or may involve the skin only over large areas about one or both sides of the face and forehead and downward onto the neck; the lesions grow only as the child grows, not diffusing any further into the normal skin, the vessels remaining about the same in size with no apparent thickening of the involved skin over the years. These are the so-called nevus flammeus or port-wine stains that are frequently seen. There is usually no extension of this port-wine stain lesion into the subcutaneous or deeper structures. At birth or a few weeks after birth there may be small to large hemangiomas that are raised above the normal skin margins and extend slightly into the subcutaneous tissue but with no apparent fusion of the enlarged vessels about the periphery into the skin or the deeper structures. The appearance, color and structure of this lesion has the appearance of a strawberry and is therefore called the strawberry nevus. The larger vesseled tumors known as the cavernous type of hemangioma not only affect the skin but also penetrate into the subcutaneous tissue and the deeper structures, and may become very much enlarged and diffused slowly or rapidly through the surrounding structures, producing large destructive masses with attendant marked deformities.

Over the years a great deal of work has been done and much has been accomplished in the care of these lesions. Many different men utilizing various methods of treatment have obtained excellent results. Treatment other than surgery that is well planned and in proper hands has given excellent results both functionally and cosmetically in selected cases. There are also certain areas especially around the eyelids where conservative treatment is advisable rather than surgical interference. It is my belief that the three aforementioned specialists should always consult together freely to determine the best treatment or combination of treatment in these cases, especially the borderline cases. This will prevent many of the complications which could arise from the standpoints of both the patient and the doctor. The earliest and most effective care of this group of lesions causing the least possible amount of destruction and deformity is naturally our aim, and I strongly believe that the combined cooperation of the plastic surgeon, the dermatologist and radiologist can be the determining factor in bringing about a much clearer and more concise method of treatment with a better end result if the cases are thoroughly studied and the proposed treatment carried out immediately. We are all aware that the smallest lesions may remain stationary in size, but sometimes within a very few weeks a small lesion can grow rapidly and extensively with much destruction of the surrounding tissues. There is also one other very important consideration, i.e., that the follow-up observation of these patients after their initial care is most important as there may be some recurrence of the hemangioma about the treated or operated area and further care is necessary.

The purpose of this article is to describe the

several types of hemangiomas and to present cases and end results following their surgical repair. We have in some instances used sclerotic solution prior to surgery. Multiple excision of some of the larger tumor masses has proved quite satisfactory in selected cases.

Etiology. A lengthy discussion as to the etiology of these hemangiomas is not necessary in this paper. Considerable work has been done on the subject and I think it is sufficient to state that the angiomas are present in independent groups of blood and lymph vessels which in some manner have been cut off and have become isolated to form a tumor mass consisting of lymph or blood vessels. If the tumors are not present at birth, they may develop and enlarge within a few weeks after birth. It is not definitely known why this occurs.

There are two main groups of hemangiomas: (1) capillary hemangiomas: nevus flammeus (port-wine stain); telangiectasis. (2) cavernous hemangioma: superficial or strawberry type; deep hemangioma, arteriovenous.

TREATMENT

There have been and still are different methods used in the treatment of hemangiomas. It is my belief that they all have a place if used with discretion. CO_2 snow has been used successfully on some very small lesions as well as fine cautery in the case of small telangiectatic lesions. Chemical injections, such as sodium morrhuate in small graduated doses injected at intervals of a few weeks especially about the nose and the eyelids, have been successful in clearing up some of these lesions without surgical interference. I have used sodium morrhuate in combination with surgery, with effective results. There is a certain amount of pain following the injection of sodium morrhuate if the solution is used in too large a dose, and at times some ulceration may result if the injection is too superficial. I have gradually cut down the size of the injection or dosage of sodium morrhuate, using only 3 to 6 minims by making multiple injections interstitially in the lesion at intervals of three to four weeks. This has proved a little more effective in my hands than the use of the larger injections. The use of gold radon seeds in certain selected cases has given very excellent results and only a minimal amount of surgery may be required in some after successfully treating the hemangioma, namely, the removal of the redundant tissue present about the treated area. Radiation such as radium and x-ray in selected cases and in the proper hands has also given excellent results.

SURGICAL TREATMENT

Nevus Flammeus (Port-wine Stain). This lesion involves the upper and deeper areas of the skin only. It is an accepted opinion that surgery should not be performed in most of these cases. There are, however, cases in which the lesions are not widespread and they can be removed surgically, either primarily or by multiple excision; this procedure, then, is of value but in a very small percentage of cases. Skin grafting following the surgical removal of port-wine stains is not advocated, as the skin-grafted area produces as much or more of a defect than the primary lesion. The tattooing method as advocated by Conway and several others in this country has been reported to have had satisfactory results. This may prove of more value in time. "Covermark" has for some years been used very successfully in masking these discolorations.

In spite of my previous statement that in most instances the port-wine stains are better cared for by the use of "covermark" rather than any other form of treatment including surgery, I do want to illustrate one case in which surgery was performed. Figure 1 shows a patient with a large port-wine stain involving the right cheek and extending along the right side of the nose, right upper lip and right lower eyelid region. This lesion also extended into the right inner canthus. The photograph was taken following the first multiple excision. The patient did have good relaxation and I thought that if the area involved could be partially excised it would be a distinct advantage to this patient. There had also been some thickening of the lesion below the right lower eyelid. Figure 2 is the end result in this case but at the time the photograph was taken one can see that there is a small amount of hemangioma present along the lower inner half of the eyelid and at the inner canthus. This is cared for very well by a small amount of "covermark" which the patient had on at the time this picture was taken. The color of the skin graft is excellent and the surgery did seem justified in this case. In many cases of smaller port-wine stains I believe that surgical removal can be accomplished with satisfactory results.

FIG 1. Port-wine stain of right side of face and right lower eyelid area. Appearance following first multiple excision.

FIG. 2. Same case as Figure 1. Final result following multiple excision eyelid graft from behind the ear; small discoloration still present along the lower right eyelid area, easily masked with a little "covermark."

Strawberry Type Hemangiomas. I believe that most strawberry type hemangiomas are best cared for by surgical removal primarily. There are times, however, when the location of the hemangioma (such as about the eyelids) may preclude surgical therapy. If so, other forms of therapy may be indicated and in many cases frequent injections of small doses of sodium morrhuate will completely clear up the lesion. It is not uncommon, however, that one of these small strawberry type lesions will become quite activated even after radium or x-ray treatment, with very rapid growth; or the physician may find that a small lesion spontaneously begins to grow very rapidly and in a very few weeks a large tumor mass is present which involves the deeper structures surrounding the original small lesion on the skin. Such a case is illustrated in Figure 3. The small elevated hemangioma seen on the skin measured about ¼ inch in diameter. In a period of approximately three and a half weeks it had become very diffuse and involved the deeper structures, extending up to the inner canthus of the right side and downward to almost the level of the corner of the mouth in the right cheek area. Because of the history and rapid growth of this blood vessel tumor, I believed that immediate surgical excision was indicated. Figure 4 shows the same patient several years later. There is normal action of the muscles on the right side of the face, with complete absence of the hemangioma; a very small scar line can be noted.

Cavernous Hemangioma. In the cavernous type of hemangioma a small area of the skin and subcutaneous tissue may be involved; then again, it may enlarge to include a very large area about the body, penetrate deeply and become very diffuse. An example of a large cavernous hemangioma is seen in Figure 5. This patient's entire left upper lip was involved, with the hemangioma extending over to the medial portion of the left cheek area. The hemangioma extended straight through the muscle of the lip and into the buccal surface of the left upper lip region. This case represents cavernous hemangioma which has been treated with radium on three occasions, with a very slight beginning regression of the tumor mass but continued enlargement following the second and third treatments. Under these circumstances it was thought that surgical excision should be done. My first impression was to do wide removal of the entire left upper lip and a portion of the left cheek area, with subsequent reconstruction of this defect. I finally decided to perform a multiple excision and the entire mass was removed in three stages. Figure 6 shows this child at the present time, with the small defect of the

FIG. 3. Strawberry hemangioma of the right cheek with a developed cavernous hemangioma of three and a half weeks' duration.

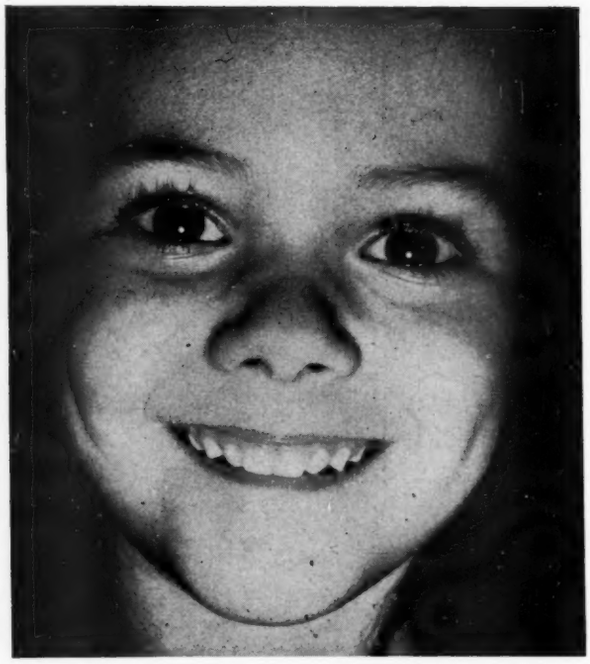

FIG. 4. Same case as Figure 3. Final result several years later. There is no recurrence; seventh nerve intact on the right.

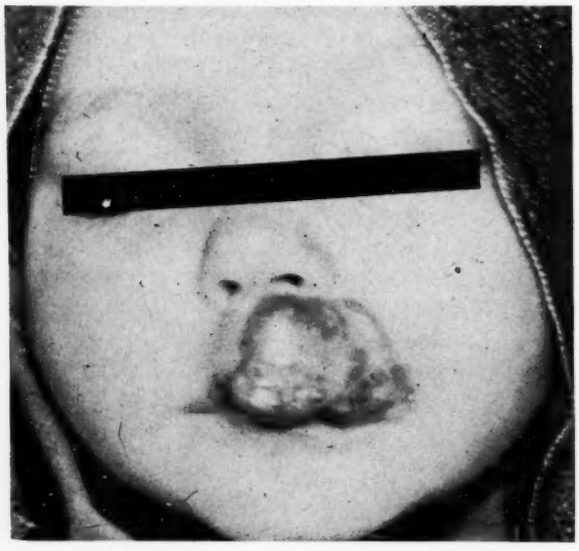

FIG. 5. Large cavernous hemangioma involving the upper left lip and a portion of the left cheek extending through and involving the buccal surface.

FIG. 6. Same case as Figure 5. End result to date following multiple excision of the cavernous hemangioma.

vermilion border present in the upper lip area; the left ala is elevated slightly above normal and the small scar line is seen along the left upper lip, the left alar region. There has been no recurrence of the hemangioma and the lip is softening normally. After a period of time a repair will be done about the vermilion border, left ala and the remaining scar of the left upper lip area. This procedure, I believe, will give a better end result with less scarring about the face and upper lip area than had repair been done with a flap operative procedure.

Figures 7 and 8 illustrate a case of extensive cavernous hemangioma involving almost the

FIG. 7. Diffuse cavernous hemangioma of the left face, left temple, and upper and lower eyelid regions, present since birth.

FIG. 8. Same case as Figure 7. Postoperative result following several procedures of multiple excision.

FIG. 9. Very extensive diffused cavernous hemangioma of the right face, right upper and lower lips and right temporal muscle; buccal surface also involved on the right.

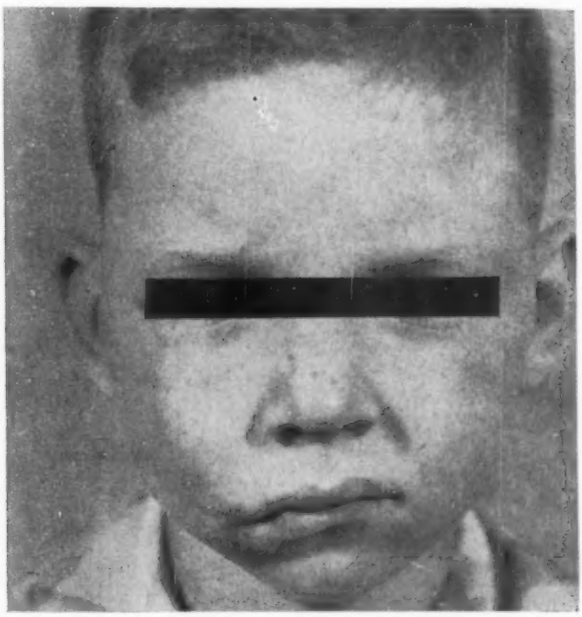

FIG. 10. Same case as Figure 9. Postoperative result.

entire left cheek and left upper and lower eyelid areas, extending laterally and upward onto the temple and to the anterior area of the left ear. This multiple diffused cavernous hemangioma was present at birth and remained about the same in size as shown in Figure 7. This diffuse growth was made up of two or three larger areas of cavernous hemangioma and several smaller hemangiomas. Considerable redundancy was present about the left side of the face and I was able to remove these masses entirely by multiple excision in a series of operative procedures. No other form of treatment was used or considered necessary. In selected cases such as this I believe that radon seeds could have been used effectively. Figure 8

shows the end result in this case after several years.

Other types of cavernous hemangioma are those which involve deep areas, especially about the face and neck, such as the lesion shown in Figure 9. This cavernous hemangioma was present at the patient's birth but was a very slow-growing lesion. It involved the upper and lower lips to include the skin and deeper structures of the right side of the face and extended up to and involved the right temporal muscle. There were several projecting areas of hemangioma on the buccal surface of the right cheek and there was occasional bleeding when the patient bit down on these areas. The right temporal muscle, which was invaded by the hemangioma, was resected; at the same time some of the larger vessels about the right cheek were ligated. Following this excision, the discoloration and swelling present about the right side of the face gradually decreased. The buccal projections of hemangioma of the right cheek were surgically removed and multiple injections of sodium morrhuate from 3 to 6 minims were made throughout the cheek and lip areas and on the buccal surface every few weeks on several occasions. This boy made an uneventful recovrey and Figure 10 shows the end result.

SUMMARY

1. Surgery is not usually indicated in cases of telangiectasis and port-wine stains.

2. The earliest possible care should be given all hemangiomas of the strawberry type and cavernous type, whether the treatment be surgical or any of the other methods indicated.

3. The close cooperation and study of such cases by the plastic surgeon, the dermatologist and the radiologist will serve a very definite purpose in determining the best method of treatment in the care of hemangiomas.

Bilateral Facial Agenesia (Treacher Collins Syndrome)

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WITH the progress of medical knowledge the rare and unfamiliar diseases of the past are becoming more recognizable. Anomalies which once were discussed only in specialty groups now are presented at national meetings and published in journals that reach every portion of the world. This has been the past history of a condition known as bilateral agenesia of facial structures. Defects and developmental abnormalities of every organ in the human body have been observed and recorded, but none with more pity than those of the face. This exposed area receives the attention of all, and often precipitates psychiatric differences in the child patient and may lead to psychosociologic problems for the parents. A six year old boy with bilateral facial agenesia, presently on our service, has never been recognized nor cared for by his own parents because "he does not resemble either parent or the other children in the family." There are very few articles in the medical literature presenting the syndrome of bilateral facial agenesia and all that were reviewed mentioned the rarity of the disease. Contrary to this belief, personal communication from a number of surgeons revealed that nearly all of them had seen a patient with this disorder and many stated that they had examined more than two of these patients. In the past ten years, the author has examined seven such patients.

There is much controversy in regard to who published the first report. Due credit is given E. Treacher Collins,[1] an English ophthalmologist, who in 1900 described and printed a picture of this condition. Many physicians today insist on the term "Treacher Collins syndrome" as the name of this clinical entity. There are others who believe an injustice has been dealt to Berry[2] who published a description of the same condition in 1888. An article written by Straith and Lewis[3] in 1949 is generally recognized by most physicians as the first paper on the subject to appear in the American literature. They reported on a family of five, all having the typical features of this complicated anomaly. None of the authors previously cited are responsible for a description of the entire syndrome. Various observers have aided in fitting the objective findings together. For this fine piece of collective effort we are indebted to such people as Mann and Kilner,[4] Johnstone,[5] Franceschetti and Zwahlen,[6] O'Connor and Conway,[7] and others who probably will never receive the credit they deserve since their articles appeared in journals with a limited distribution and under titles not recognized. The group of symptoms has been classified in various ways; such as, Treacher Collins syndrome, dysostosis mandibulofacialis, dysplasia foetalis, Streeter's facial dysplasia, facial asymmetry, desmoplasia, dysgenesis facilis, malar bone deficiency, associated congenital defects of the face,[8] Franceschetti's syndrome,[9] focal deficiencies in fetal tissue, Pierre-Robins syndrome and others. Therefore, one should not be surprised to find a controversy existing as to who published the original article on this interesting and unusual congenital deformity.[10]

The etiologic background of these defects is still obscure although there are many interesting theories. Streeter[11] thought that the source of many forms of congenital malformations was a fault inherent in the chromosomes of the fertilized ovum. Ingalls,[12,13] after reviewing a series of human fetuses between the second and third month of development which showed dysplastic defects, subscribed to similar views as those of Streeter. On the other hand, Mall[14]

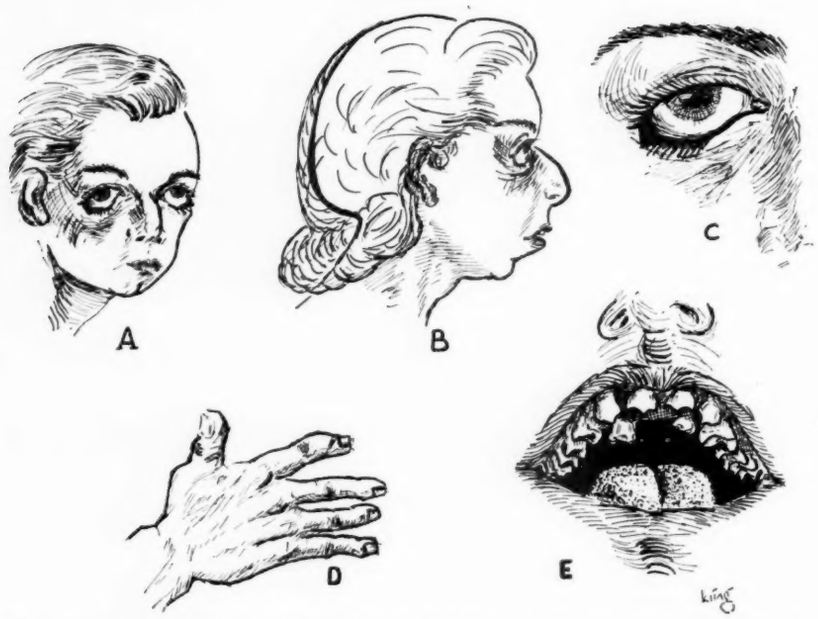

FIG. 1. A, the patient with bilateral facial agenesia presents a diagnostic "mournful facies." B, the occipital bone has a protruding bossa, there is malgenesis of the auricles, micrognathia is present, and because the malar eminences are underdeveloped the nasal contour is relatively large. C, the lower eyelid exhibits a webbing at the external canthus, an integumental notching and an absence or scarcity of cilia along the medial margin. D, many times there is clinodactyly. E, interdental widening is common and sometimes a duplication of the permanent teeth is seen.

believed that normal embryos could be influenced by environment and suggested that poor nutrition caused a faulty implantation of the fertilized ovum in the uterus. Keith[15] has called attention to placental circulatory failure or possibly a breakdown in the circulatory system of the fetus as an etiologic factor. Another concept was offered by von Winckel[16] who observed a patient and exhibited a drawing of amniotic adhesions (fibrous bands) between the placenta and fetus. Mundell[17] and others have observed anomalous children born of mothers who were exposed to x-ray during pregnancy. Among the many other theories that have been suggested are pressure and position of the fetus while *in utero*, vitamin deficiencies, protein metabolic changes, temperature differences, administration of drugs to pregnant women, and various systemic diseases[18] such as diphtheria and diabetes. Many writers believe that virus infections, especially rubella,[19–21] play an important part in causing congenital deformities. Embryologically this developmental anomaly is associated with some defect in the growth pattern of the first (mandibular) visceral arch, groove and pouch. This combined branchiogenic structure is responsible in forming the adult lower lip, mandible, muscles of mastication, anterior part of the tongue, the cheek, upper lip, the auricle, external acoustic meatus, auditory tube, tympanic cavity, temporal, maxillary and malar bones. Mann[4] has adeptly described the formation of these facial structures and clearly reveals the anomalies taking place during the 50 to 60 mm. embryonic stage before the beginning of the third fetal month.

After the physician recognizes his first case of bilateral facial agenesia he will never fail to diagnose another. Although there may be an incomplete representation of all the deformities that are included in the syndrome, there will be enough of the associated anomalies to make the diagnosis. The complex clinical picture consists of the following features. (Fig. 1A to E.)

1. Eyes: The upper eyelids tend to relax at the outer edges. This drooping plus the notching or colobomatous deformity at the lateral third of the lower lid produces an oblique palpebral aperture. The inferior eyelid is different also in that it is rather thin and atrophic, has poorly developed orbicularis

oculi fibers, presents a lack of lid margin, exhibits an absence or decrease in cilia and meibomian glands in its medial two-thirds or one-half and sometimes is void of puncta.[7] There is usually a skin webbing of the external canthus which has not been described previously. These defects of the eyelid produce the facial expression of sadness which is misleading because the patient usually is very happy, talks freely and smiles a great deal during the course of conversation. There is good binocular vision and the extraocular muscles function normally.

2. Maxilla and malar bones: X-rays present thin infraorbital ridges, hypoplastic maxillas, depressed malars and small antrums. There may be a palpable nodule at the medial end of the zygoma, and one observes either a high foreplate or sometimes a cleft palate deformity.

3. Ears: There may be a partial or complete agenesia of the external auricle, absence of the external meatus and canal, and usually bilateral deafness. The patient hears exceptionally well with a hearing aid.

4. Nose: The nose is usually large but appears more so because of the rudimentary malar bones. The respiratory passage is normal and olfactory sense is present.

5. Teeth: Most of these patients have an irregularity of tooth spacings and also exhibit malocclusion. A duplication of permanent teeth has been observed.

6. Mandible: Micrognathia is the usual finding and in the newborn this is dangerous because the tongue is relatively macroglossic and may cause respiratory embarrassment and possible asphyxiation. The infant breathes easier when placed in the prone position.

7. Occipital bone: Some authors[22] have described bossing of the external occipital protuberance which is both visible and palpable.

8. Extremities: Fingers or toes may show evidence of clinodactyly. The metacarpals or metatarsals are usually exceptionally long.

9. Unilateral and bilateral cleft lips[8,23] associated with this syndrome are not unusual.

Of seven patients observed by the author, not one exhibited all of the aforementioned findings, but every one had sufficient facial defects so the diagnosis could be made. It is interesting to note that the older patients presented no gross mental deficiencies, but instead were intelligent and cooperative.

The therapeutic approach to this syndrome is a diversified one and entails many basic principles of surgery. It is a combination of plastic and reconstructive surgery and the utilization of multiple procedures is a necessity. In the adequate restoration of such patients one may have to use Z-plasties, blepharoplasties, skin grafts, cartilage or bone grafts and derma-fat grafts. Otoplastic and rhinoplastic procedures are useful in correcting the existent deformities of these anatomic structures. Some patients even need cheiloplasty or palatoplasty. These many surgical technics will be discussed with each existing anomaly.

Eyelid Deformities. When the lower eyelids and external canthi are elevated by temporary digital fixation, the examiner changes the oblique fissures to a normal position. This may mislead the surgeon into attempting support with some type of suture, muscle or fascial sling from a higher structure. This procedure has been attempted by anchoring the support to the temporal fascia and bone, but the desired result was not achieved. When the upper eyelid is used to support the lower, a drooping of the assisting lid results without correction of the deformity. O'Connor has corrected the lower eyelid notching by Wolfe grafts, intermarginal adhesions and the Wheeler halving operation. I have used the Kuhnt-Szymanowski procedure which is satisfactory in restoring the lower eyelid into a more normal position, relieving the skin web at the external canthus and partially correcting the palpebral obliquity. This latter anomaly is corrected further by a derma-fat graft, to be described later. Although derma-cilia grafts may be used to replenish the lower lid, it is thought to be unnecessary.

Maxillary and Malar Bone Anomalies. The depressed middle face may be elevated by various types of transplants including autogenous bone, cartilage, skin or fat. Many surgeons prefer homologous grafts and some have used heterogenous grafts to achieve these results. Plastic prostheses are being used more often, but still with caution. Blocker[24] has accomplished very satisfactory malar contour by using derma-fat grafts; this is the procedure I employ. The hair in the temporal areas is shaved, the entire forehead, face and neck are surgically cleansed, the hair near the temporal regions is sprayed with aeroplast or laid flat with sterile vaseline, and the head is aseptically draped. An incision is made along the hairline, and by blunt dissection a tunnel is constructed

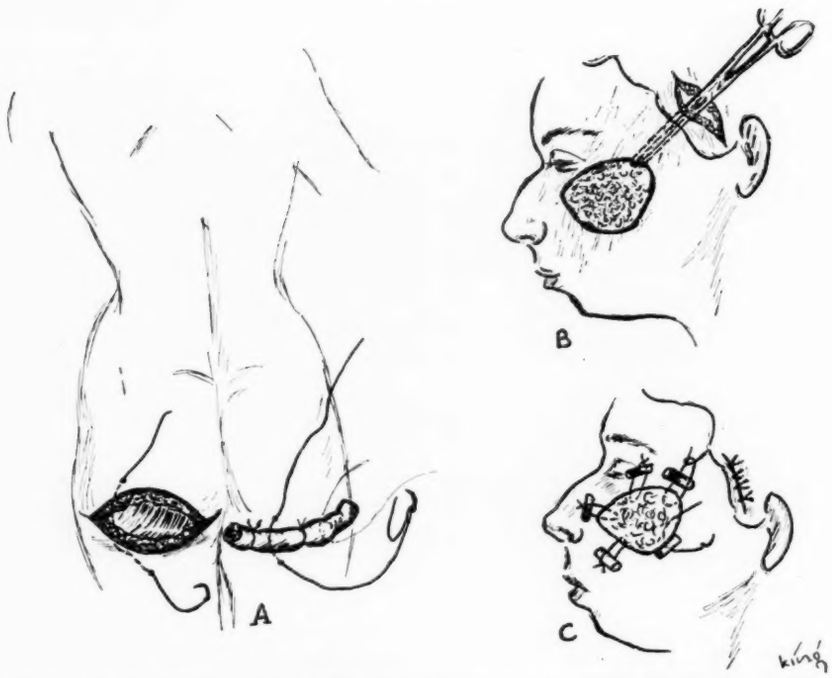

FIG. 2. A, the left buttock exhibits the infragluteal donor site of the derma-fat graft and the right buttock illustrates the wound closure using stent sutures of stainless steel wire tied over a gauze dressing. B, drawing showing the insertion of the graft with the dermis deep and the fat layer superficial beneath the skin of the face. The portal of entry is an incision in the temporal area posterior to the hairline. C, half-buried mattress sutures of stainless steel are tied over cotton bolsters to fix the graft into position.

to the malar area. After undermining the soft tissues without damaging important branches of the facial nerve, hemostasis is accomplished. A similar procedure is carried out on the opposite side. These areas are then covered with a sterile drape. Any portion of the body with a sufficient adipose layer may be selected as the donor site for the graft; generally I choose the abdomen or buttocks. When the buttocks is preferred, this region is surgically prepared and the size of the desired implant is outlined in the gluteal fold. A dermatome is used to remove the superficial integument, exposing a raw dermal layer surface. More adipose tissue is dissected than is needed because 20 to 50 per cent of it is lost by absorption. The gluteal wound is closed (Fig. 2A) by undermining the soft tissues, obliterating the dead space with stent sutures and coapting the integumental edges with a subcutaneous pull-out suture. Stainless steel wire is used throughout. A dressing composed of Owens surgical fabric and 4 by 4's is placed upon the wound and held in position by tying the stent and pull-out wires over it. No other dressing is necessary. The implant is then inserted into its recipient area in the operative area of the face. (Fig. 2B.) Care is taken to position the raw dermis deep and the fat portion of the graft superficially since adipose tissue receives a new blood supply poorly. Steel wire sutures are used in mattress fashion and tied over cotton bolsters in order to hold the graft *in situ*. (Fig. 2C.) The temporal wound is closed, and the other malar deformity is elevated by the same procedure. A head bandage with moderate pressure completes the operation.

Auricular Agenesia. Complete absence of the ear necessitates total reconstruction and many surgical procedures can be used to accomplish this. These operations usually are effected by skin and cartilage grafts and skin tubes, and are followed by touch-up procedures. Some surgeons prefer auricular prostheses. If an ear is present, a portion or all of it is usually deformed and out of position. This is maneuvered into a more normal position by shifting soft tissues and using Z-plasties. The ear is held in

FIG. 3. Preoperative photograph showing facial features of patient with the Treacher Collins syndrome.

FIG. 4. Postoperative photograph of patient in Figure 3 following repair of the anomalies.

FIG. 5. Preoperative profile view of patient exhibiting ear deformity and flat malar eminence with relatively large nose. First cartilage graft to mandible has been accomplished.

FIG. 6. Postoperative lateral view of patient in Figure 5 showing resultant rhinoplasty. The derma-fat graft has been positioned and a second bank cartilage transplant added to achieve a more normal chin contour.

its new site by deep sutures or fascial slings attached to the surrounding periosteum. One of my patients had anomalous auricular appendages and complete bilateral absence of the external auditory meatuses without skin dimpling. X-rays demonstrated the presence of mastoid air cells and possible tympanic cavities. The patient was found to have bilateral deafness and had never spoken an understandable sentence. He also had a complete cleft lip associated with a cleft palate. The lip and palate had been repaired earlier. When the patient was six years old ear construction was attempted bilaterally, by first exposing

the deep soft structures of the otic region. A tympanic membrane was thought to be visualized on one side and therefore a split-skin graft was positioned using dental compound as a mold to stent the graft. The contralateral auricular area was operated upon also but no definite ear structures were found. Regardless, a stent split-skin graft was also used on this side. The patient now has moderate auditory perception and is able to talk in sentences. He is intelligent, and with speech training and a hearing aid should make progress. The external appendages are in the stage procedure of construction. Cartilage grafts have been positioned under skin flaps and later the helices will be simulated by tube flaps.

Nasal Deformities. In cases of bilateral facial agenesia the internal nose is supplied with a good air passage and normal olfactory function. The external nose is large throughout and appears more so because of the absence of malar eminences. There is usually an enlarged nasal bridge associated with a bulbous tip. Routine rhinoplasty accomplishes a satisfactory cosmetic result. (Figs. 3 and 4.)

Dental Anomalies. Various irregularities of the teeth exist, including interdental widening, superior alveolar protrusions and duplications of permanent teeth. These are problems which are referred to the orthodontist. The palate may be high-arched and sometimes is cleft.

Mandibular Agenesis. To improve this deformity, the usual procedure is to utilize bone or cartilage as a graft; both autogenous and homologous types are acceptable. Though some surgeons prefer the intraoral approach to position the graft, I use the external inframandibular incision. A wedge is elevated with the chisel in two portions of the mandible and the graft is positioned in these. Steel wire sutures are then used as tie-overs to hold the graft in position. The wires are removed on the tenth postoperative day. In the newborn who exhibits respiratory difficulty because of the relative macroglossia, I use fascial graft slings through the base of the tongue which are sutured to the mandibular periosteum, thus advancing the posterior tongue and producing an open airway at the oropharynx. (Figs 5 and 6.)

SUMMARY

The purpose of this paper is to focus attention on a group of congenital facial anomalies which when assembled present a definite clinical entity. Authors have described various parts of this syndrome with the sincere impression that something new had been added to the literature. Although it is the consensus of many that this is a rare disease, it has been found to be more common than previously believed. This misunderstanding is possibly due to the various names attached to the syndrome. These patients have a normal intelligence and deserve surgical reconstruction.

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Principles of Reconstructive Surgery of the Hand

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THE surgical complexities of the hand are such that proper management requires skill and understanding gleaned only through contact with the major specialties. Dr. Sterling Bunnel has stressed the importance of combining with a general surgical background orthopedic, plastic and neurologic training for those interested in the problem. It is difficult, in general, to ascribe more importance to any one tissue than to another, but certainly coverage is paramount, for only through its integrity can the vulnerable deeper structures of the hand survive and function be restored.

More deformity is encountered secondary to skin loss and cicatricial contracture than from any other single factor, for without adequate relaxed integument, functional mobility of the hand is restricted. Cutaneous and ligamentous elasticity which permits unrestrained joint function is readily lost by malposition, prolonged edema and too often by a misguided surgical incision. In primary treatment the skin is most important, for unhealed areas invite infection, deep necrosis and prolonged disability. Skin closure is probably the most basic technical procedure, yet one of the least stressed in general training. Healing is often curtailed simply because the wound edges have been imbricated, rather than meticulously coaptated.

A wound may require a free or pedicle graft for closure but the inevitable cicatricial border contracture and possible joint restriction can be reduced by careful placement of incisions. Skin loss is a primary concern, however, and coverage is expedient, even if function is temporarily curtailed. Free grafts are often necessary and desirable for closing areas where a pedicle flap may ultimately be needed This secondary flap must permit any necessary deep reconstruction; its borders should be placed mid-laterally to joints and parallel to flexion creases, thereby imposing no restriction on mobility. Principles governing single incisions also govern the design and the placement of pedicles. (Fig. 1.) Adequate coverage can be provided and secondary contractures minimized when an understanding of hand function and the reconstructive potential is applied to the problem.

Injuries to the hand are divided roughly into two major categories: first, those with loss of tissue and second, those without. Concern herein will be primarily with the former, with special reference to the effect on function. Restoration of stable coverage by free or pedicle skin grafts is concerned with the unrestrained mobility of the hand and protection through its durability and sensation. The presence of sensation in many grafted areas is vital to the usefulness of the part and warrants full consideration. In view of the important sensory role delegated to skin, that portion with sensation must be preserved and shifted if possible to the working aspect of the digit. It is not the purpose of this paper to discuss peripheral nerve surgery, but specific mention should be made of the use of a neurovascular pedicle skin island transfer to provide sensation where it is most needed. An anesthetic hand is a blind hand; it is in a constant state of jeopardy with respect to trauma and contributes to the individual only when it is under constant surveillance.

Minor losses of skin are generally easily managed, except in specific areas where important adjacent structures are exposed or where stable coverage is required, as for example the stump of a digital amputation. Full-thickness thermal burns and avulsion injuries with exposure of deeper structures demand resurfacing often with a combination of free

and pedicle skin. Free grafts are excellent for the dorsum of the hand but the thumb web (first interosseous space) and volar aspects generally require pedicle skin to liberate the first metacarpal and phalanges from cicatricial restraint. (Fig. 2.) When a pedicle flap is required to resurface the dorsal or volar aspects of multiple digits, a syndactylism must be created. Separation of the digits can be carried out after resurfacing has been completed, but this is not always necessary in cases in which only proximal phalanges remain. Carefully designed direct pedicle flaps, generally from the abdomen, and that part of the donor defect not easily closed is covered with a free graft. (Fig. 3.) Unhealed donor areas complicate enormously the postoperative care, and great expense and loss of time is entailed. Detachment must often be done in a contaminated field, endangering the flap and deeper structures by potential infection and delayed healing.

The major concern following healing in a severe destructive injury to the hand is to restore the remaining architecture and mobility as soon as possible. Active effort combined with passive mobilization of joints through exercise and dynamic traction supplement the time factor required for the remainder of the hand to soften following extensive damage and cicatrization. This effort must proceed from the initial treatment when the foremost consideration is closure of wounds and a careful functional positioning of the hand. This feature of hand care, like placement of incisions, has been emphasized repeatedly, yet positional disability continues to complicate and frustrate secondary recovery. Without a practical knowledge of structural and functional anatomy, sound basic care cannot be rendered the disabled hand. Because of the absolute requirement of good coverage in both primary and secondary hand care, plastic surgeons are expected to meet this need. The structure to be covered demands the simple elements of thumb abduction: digital flexion and extension. Deeper contracted, adherent or disrupted structures must be considered and their management not thwarted by inadequate coverage. A successful program of reconstruction is predicated on uncomplicated healing especially when bone, tendon and nerve repairs are required.

Prolonged immobilization in malposition is a

FIG. 1A. Mid-volar longitudinal incision for primary tendon repair, left index finger. Transgressing principle of finger exposure resulting in a flexion contraction and loss of function.

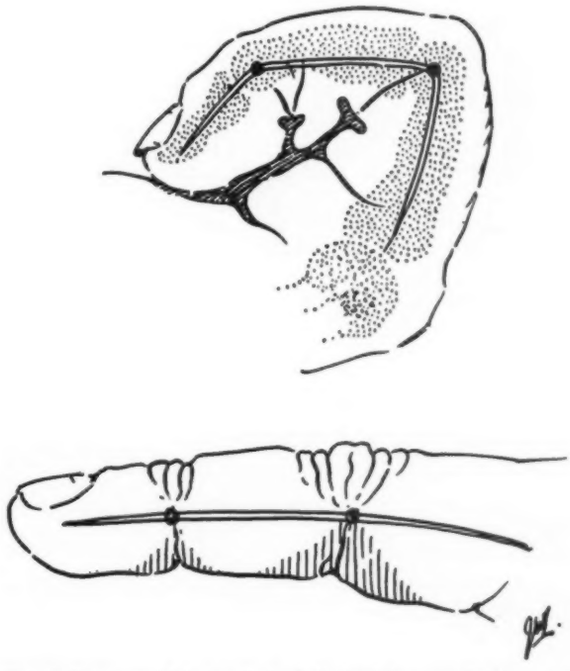

FIG. 1B. A mid-lateral (axial) incision undergoes no change in length on flexion and extension of a digit, and is restrained from contracture by the lateral stability of the joints. The infolding mechanism of volar skin and the ease with which a mid-volar longitudinal incision can fix the interphalangeal joints in flexion is illustrated in the top drawing. Parallel flexion crease lines (bottom drawing) illustrate the area vulnerable to a longitudinal incision. The skin incision is only the entree to deeper structures, and extreme care (especially in the digit) must be taken in dissecting a volar skin flap, with its neurovascular bundle, off the undulating joint and flexor tendon mechanism.

FIG. 2. Severe adduction contracture of the thumb with loss of palmar and wrist coverage resurfaced with a direct abdominal flap with a delayed attachment to provide radiodorsal wrist and first interosseous coverage. A special Kirschner wire skeletal distraction splint is shown. Following healing, dynamic (elastic) distraction will be substituted. In resurfacing the first interosseous space, the flap is generally most easily applied over the dorsoradial aspect of the first metacarpal with a triangular prolongation into the palm, thereby preventing any scar bridging the intermetacarpal cleft.

FIG. 3. Avulsion of skin of hand over both palmar and dorsal aspects requires pedicle coverage preceded at times by preliminary free grafts. Despite presence of proximal phalanges in this case, phalangization would contribute no increase in function and actually would make the final result less acceptable cosmetically. Illustration shows avulsed dorsum of the hand covered with primary pedicle and delay of flap for palmar resurfacing.

common cause of disabling contractures of the hand, especially when complicated by local injury and pain. A flexed wrist increases the extensor pull on the proximal phalanges, thereby favoring metacarpophalangeal hyperextension and secondary contracture of the collateral ligaments. When the thumb is in the adducted position web skin, fascia and intrinsic muscle contracture is initiated. The flat extended hand disrupts and reverses the normal longitudinal and transverse arch mechanism, thereby destroying the capacity to encompass and grasp objects. (Figs. 4 and 5.)

Ischemia from arterial damage secondary to crush, lacerating wounds of the arm and forearm, and especially a supracondylar fracture may produce a Volkmann's contracture, especially when arterial insufficiency is combined with venous obstruction and external pressure from an unyielding plaster. Plaster is to be used for immobilization and never as a tourniquet. It is of major importance postoperatively to be certain that venous return is unimpaired, and that a stellate ganglion novocain® or xylocaine® block be performed if there is arterial insufficiency. Strangulation of the hand and forearm by a tight dressing or plaster is one of the most common errors of management, especially with the hand in poor position. Constriction, if not relieved, leads to edema distally and increased pressure indicated by pain, unless sensation is impaired, can result in skin necrosis, intrinsic muscle ischemia and ultimate fibrosis of the entire hand. Encirclement of the transverse metacarpal arch with plaster for fractures must not strangulate the soft tissues. Skin necrosis and incorporation of flexor tendons in cicatrix over the palmar aspect of the proximal phalanx is frequently the outcome of traction reduction of simple metacarpal or phalangeal fractures.

Transient edema accompanies all trauma to a degree, but when prolonged the effect on the normally mobile hand is disastrous, gliding surfaces suffer and the hand is stiffened. In extreme cases organized fibrin is deposited, especially in the subcuticular layers of the skin, and a frozen hand may result. Edema with its dire consequences must be combatted from the onset of treatment in injuries to the hand, especially when it is common knowledge that a relatively minor affliction can affect the entire extremity and lead to a disability far exceeding the original anatomic disorder. A basic under-

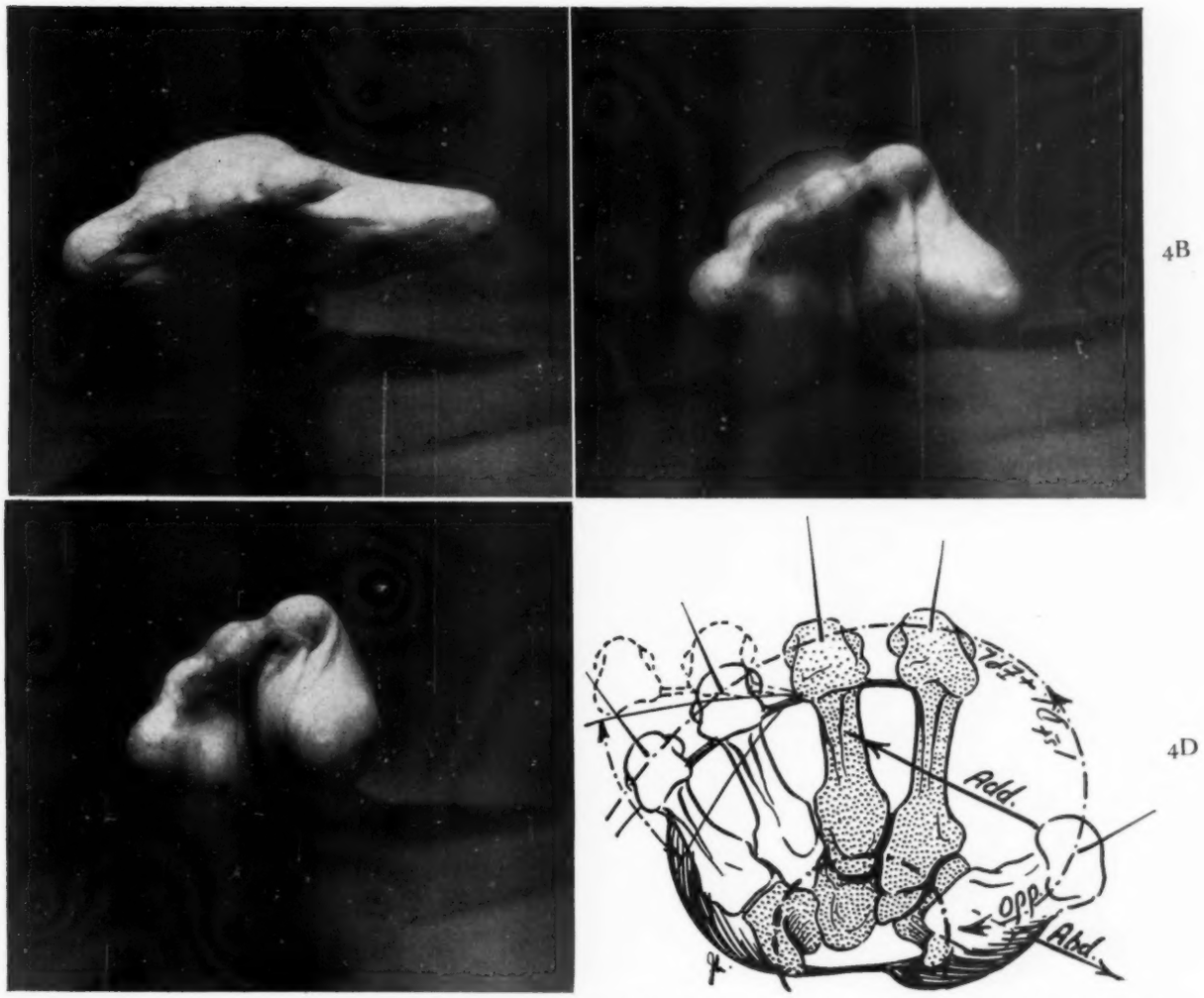

FIG. 4. The fundamental structural and functional aspects of the human hand can best be understood through a simple analysis of its transverse and longitudinal arch mechanism. Both arches have a fixed and an adaptive component. The transverse carpal arch and the second and third metacarpals form a fixed proximal unit (dotted segment in D). The transverse metacarpal arch is formed as an extension of the carpal arch but is made adaptive or variable through the first, fourth and fifth carpometacarpal articulations. Although the first metacarpal is independent, the fourth and fifth are linked to the central fixed second and third through the intermetacarpal neck ligaments. The transverse metacarpal arch is developed by the opponens pollicis and the opponens digiti quinti muscles which originate from the hooks of the greater multangular and hamate bones, respectively, and from the volar carpal ligament (A to C).

standing of the pathology of edema is essential in that a whole train of post-traumatic complications can be avoided and an optimum functional result achieved.

Atraumatic® reparative surgery performed, in a bloodless field (one to one and a half hours tourniquet time), including careful reduction and fixation of fractures and above all complete skin closure through free or pedicle skin grafting if necessary, are primary requisites. Open wounds are conducive to both edema and excessive fibrosis and must be closed as early as possible. The dressing is perhaps the keynote to a smooth postoperative course, and the degree of pressure and the manner of application will vary with the surgical problem. However, it is clear that the optimum compression supports tissue and aids in the prevention of postoperative hematoma but does not produce skin necrosis. Special care must be exercised over bony prominences, and excessive immobilization, especially of uninvolved parts, must generally be avoided. Compression by a well applied dressing is reduced proximally;

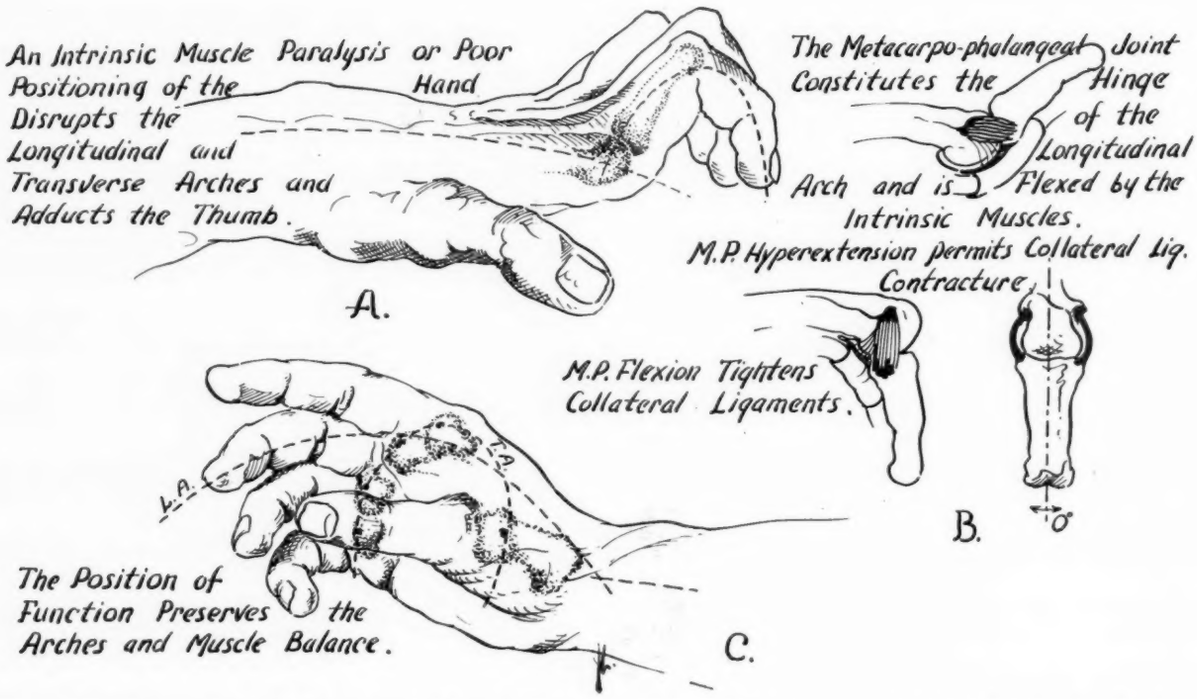
An Intrinsic Muscle Paralysis or Poor Positioning of the Hand Disrupts the Longitudinal and Transverse Arches and Adducts the Thumb.
A.
The Metacarpo-phalangeal Joint Constitutes the Hinge of the Longitudinal Arch and is Flexed by the Intrinsic Muscles.
M.P. Hyperextension permits Collateral Lig. Contracture.
M.P. Flexion Tightens Collateral Ligaments.
B.
L.A.
T.A.
The Position of Function Preserves the Arches and Muscle Balance.
C.

FIG 5. The longitudinal arches are formed by the five rays (C). Like the transverse metacarpal arch, the distal or adaptive segment of the longitudinal arch is maintained by the intrinsic muscles bridging the fixed metacarpal and adaptive phalangeal segments at the metacarpophalangeal joints. This prime joint forms the "hinge" of the longitudinal arch; when the intrinsic muscles are paralyzed, a break in the arch results and the proximal phalanges of thumb and fingers go into hyperextension (A and B).

otherwise a venous tourniquet effect is produced. During the recovery phase blood pressure determinations are not to be made on the operated arm. Postoperative elevation of the hand and relief of any constriction facilitates venous and lymphatic return. Congestion and swelling is thereby largely prevented and pain is reduced. The dressing, elevation, and elbow and shoulder extension exercises all aid in curtailing edema until such time when the immobilized hand can be reactivated through digital flexion and the normal circulatory mechanics restored.

The sympathetic nervous system appears to play an important role in some injuries and is indeed affected in all. Pain is conducted to the sympathetic centers over the afferent sensory pathways and edema can be produced by reflex venospasm. Lewis, quoted by Adams Ray of Stockholm, has shown that sympathetic venule spasm will resist a dilating force of up to 100 mm. Hg. A stellate ganglion novocaine or xylocaine block can relieve this sympathetic overactivity. However, since pain is often the precipitating factor, the aforementioned methods for its control are a first line of defense.

Immobilization of the shoulder, as needed when an abdominal pedicle flap is used to resurface the hand or forearm, may lead to stiffness if prolonged or if the arm is bound too firmly to the lateral chest wall. On the other hand, an insecure dressing will produce reflex or volitional splinting on the part of the patient and this may also lead to increased stiffness of the extremity. Pedicle flaps will have healed sufficiently by the end of ten days to permit a moderate range of shoulder and elbow movement which can be increased within a limited range without jeopardizing the pedicle until it is detached. An arm which has been attached to the abdominal wall by a skin pedicle must not be fully abducted at the time of detachment, and the flap border should be inserted while the arm is maintained in the more accustomed position. Careful surgery, adequate early immobilization, control of pain, elevation, encouragement, patient confidence and active exercise go far in preventing the development of the so-called shoulder-hand-finger syndrome.

Any lesion, no matter how limited, affects the entire hand to varying degrees and in some cases the entire extremity as well as, generally,

the emotional and economic status of the patient and the family. The management of any one damaged part must never jeopardize intact structures, and care must be taken not to convert a minor problem into a major one. This is especially true when too much surgery is inflicted on already traumatized tissues, especially in limited areas. Since fibroblastic proliferation is the basis of repair in all connective tissues, it stands to reason that any given area, with all specialized parts traumatized, can be united by a common bond of cicatrix and independent function lost, not infrequently encountered at the wrist where a consolidation of nerves and tendons often follows the added trauma of extensive repair. In severe lacerations of the wrist the structures to be united primarily are the terminal phalangeal flexors and the median and ulnar nerves. All other structures can be relegated to a relatively insignificant status with respect to these all-important structures essential for the best in hand function, namely, sensation, intrinsic muscle power and interphalangeal flexion.

One of the difficult features in reconstructive surgery of the hand and certainly in the entire realm of general plastic surgery is the variegated nature of the problem and the multiplicity of considerations required when dealing with composite tissues. A surgical program depends upon the nature of the loss, both anatomic and functional. For example, when a gross subtotal amputation of the hand is encountered, an opposing unit can be reconstructed with an iliac bone graft and abdominal flaps, provided there is one mobile element. When useful function has been lost through a major injury, prehension can often be restored through appropriate reconstructive measures but much effort may be demanded to gain little. However, it is essential that caution be exercised in coping with the problem, insuring that intact functional elements be preserved and mobilized, and that available power and sensation be concentrated where most needed. The hand is, of necessity, reduced to a lower functional status, but gaining the primary element of grasp is a significant achievement and contributes manual independence to the patient.

Joint stability is maintained through muscle balance and function through the synergism of muscle groups. The wrist extensors and digital flexors are a good example: wrist and digital extensors are strictly antagonistic and the extensor carpi radialis longus makes a poor substitute for any of the digital extensors, unless liberated by a wrist fusion. Synergistic wrist flexors are most effective when transferred to activate the thumb and finger extensors for paralysis or destruction. Without wrist and metacarpophalangeal stabilization the extrinsic digital flexors and extensors are rendered helpless. In an irreparable loss or paralysis of wrist extensors and intrinsic metacarpophalangeal flexors (interossei and lumbricals), a powerful grip can be restored through a fusion of the wrist and metacarpophalangeal joints in a functional position. Some function is lost but directed powerful useful movement is gained. When only limited power is available it must be concentrated where it will be most effective for grasp, and stability must be provided through arthrodesis.

In instances of loss of thumb mobility, especially when an adduction deformity is present, rather drastic measures may be required to restore its functional position. Pedicle skin is often needed when the first intermetacarpal cleft has been narrowed by tissue loss and contracture, and not infrequently the carpometacarpal joint must be fused. Etiology is an important factor in the management of this problem in reconstructive work on the hand, for depending on whether the contracture is secondary to ischemia, malpositioning or intrinsic paralysis, the skin may not be too greatly involved. In the simpler deformities, secondary to malpositioning and intrinsic paralysis, dynamic abduction traction may suffice to mobilize the first metacarpal. Tendon transfers, if necessary, may then be used to compensate for any intrinsic muscle loss.

These remarks on the management of reconstructive problems of the hand are not expected to provide a full, rounded presentation of this complex subject but rather to highlight some of the factors which are conducive to greater rehabilitation of the injured hand.

The Role of Reconstructive Surgery in Cancer of the Face

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The eradication of cancer wherever it exists is the prime objective of the surgeon. Rehabilitation of the patient following such treatment, particularly when it involves the head and neck, is also of great importance. Function and appearance must be brought back to normal or as near normal as possible. Treatment of advanced cancer of the face often leaves a defect which severely hinders function and leaves an unsightly patient. It is in these later roles that the reconstructive surgeon plays an important part.

Management of a given patient varies with institutional policy. In some of our medical centers the reconstructive surgeon is also a trained cancer surgeon, so that after he eliminates the new growth he can follow with its repair.

In every instance the patient's welfare is uppermost and, hence, in some hospitals where the services of a well trained cancer surgeon are available, he will remove the growth. When the cancer surgeon believes that such removal has been successfully accomplished, he relinquishes the case to the reconstructive surgeon for rehabilitation.

Again in other institutions the cancer and reconstructive surgeons work together on the case so that each is familiar with the problems at hand.

DIAGNOSTIC PROBLEM

Squamous and basal cell tumors are the most common facial invaders, and when seen early can be easily removed by excisional biopsy. Small growths offer no great problem because closure is usually accomplished by undermining and meticulous suturing. Nasal growths, particularly those of the tip, present a more difficult problem because this skin is inelastic and firmly fixed to the underlying structures, making undermining difficult. Defects of the nasal tip must be closed by adjacent flaps or free grafts. An excellent source of free grafts is the posterior surface of the ear because of the accessibility and good color match. Growths on the upper eyelid which have not invaded the underlying structures can usually be excised and the defect closed; but when this is not possible, the skin of the opposite lid may be used as a graft. The lower lid is not as amenable to simple closure of the defects because of the tendency to ectropion. This is usually prevented by the use of free grafts or sliding flaps from adjacent areas. When the growth has invaded the subcutaneous structures, a portion or all of the lid structures must be removed, thus leaving an exposed eyeball which must be covered to avoid corneal damage.

Eyelid replacement can be effected in several ways. A method frequently utilized is to separate the conjunctiva from the remaining lid structures and then suture it to the cut edges left by the excision of the growth. Skin covering may be obtained by sliding flaps from an adjacent area or by free grafts. Later the repaired area is opened to permit the eye to function. It is better to line a newly constructed lid with conjunctiva if available or oral mucous membrane. A skin surface rubbing the cornea may produce irritation and eventual loss of sight.

Advanced invasion of a new growth may require complete exenteration of the orbital contents. Plastic repair of this type usually requires a large pedicle flap from the chest or abdomen.

Cancer of the lip is rather common and is usually of the squamous cell variety. When seen early, excisional biopsy is the method of choice. A V-shaped incision is used, wider than the lesion and ending in a point. As much as one-

third of the lower lip can be removed and the remaining structures sutured together in layers. This type of incision leaves little impairment of function and an excellent cosmetic result.

More advanced lesions of the lower lip may require flaps from adjacent areas for closure, and in some instances tubed or pedicle flaps from a distance. In advanced cases radical neck dissection is usually performed for removal of lymph nodes. Whether the neck dissection is done on one or both sides depends upon the location of the lesion and the presence or absence of palpable nodes.

Carcinoma of the external ear may be either squamous or basal cell in type. Regardless of type, complete excision of the involved areas followed by plastic closure is advisable. The ear, being a cartilaginous structure covered by firmly fixed thin skin, affords little opportunity for undermining of skin and closure. When only the skin of the ear is involved, the lesion may be excised and the defect covered by either a free full-thickness or split-thickness graft.

When the deeper structures are involved, complete excision leaves a portion of the ear absent, and in this instance adjacent flaps or tubed flaps from a distance must be resorted to.

Growths of the mandible may arise from within, or by invasion. The mandible is rather complex in its origin and thus vulnerable to developmental disturbances. The smaller lesions can usually be removed without disturbing the external contour. The more advanced lesions require resection of various portions of the mandible which must be followed by repair. If the external approach has been used, immediate repair using iliac bone or rib can be carried out. If immediate repair is not feasible, some form of prosthetic appliance is used to keep the structures in line until ultimate repair can be accomplished. Autogenous grafts of any type are best whenever available. However, most institutions now have well established bone and cartilage banks which can be utilized when necessary. Antibiotics are a great boon to oral surgery because they lessen the incidence of infection and have made certain intraoral procedures possible.

Cancer of the maxilla and sinuses often requires radical surgery. Such surgery frequently leaves severe facial defects which must be corrected by plastic surgery. Prosthetic appliances such as upper dentures are utilized following extensive removal of portions of the maxilla, and in such instances the plastic surgeon calls upon the dental surgeon for assistance. When extensive cancerous involvement of the tongue exists, as much as one-half or more is excised. After hemiglossectomy, healing is greatly facilitated and function less impaired when the raw areas are immediately covered with a thin skin graft.

Parotid tumors of the advanced type require complete removal of the gland, and in some instances it is not possible to save the seventh or facial nerve, so that paralysis of the face results. Such a deformity impairs function, such as inability to drink fluids from a glass or retain saliva. Speaking is often interfered with and the lax facial tissues are unsightly. Facial palsy of this type can be much improved by muscle transplants and the use of fascial slings. The temporal muscle is used by some surgeons, while others utilize the masseter muscle. Muscle transplants in combination with fascial slings give the best results.

New growths in the scalp of the more extensive type require wide excision. Such scalp defects are closed either with rotating flaps or skin grafts. Whenever possible, the scalp flaps are so rotated that the denuded areas can be covered by the remaining hair.

Cancer of the face, because of its accessibility, offers early opportunity for diagnosis and treatment. Rehabilitation following treatment is well standardized and can do much to restore function and appearance. The cancer surgeon can feel free to remove facial growths radically, knowing that the reconstructive surgeon can do much to rehabilitate the patient. "Cancer is curable," and patients can be discharged to normal existence without conspicuous defects.

Reconstructive Surgery in Paraplegia

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APPROXIMATELY 1,000 new cases of paraplegia occur in the United States yearly. Most of these patients are young adults or are in early middle age when the hazards of work, traffic or warfare are greatest. Prior to the modern conception of supportive, chemo- and antibiotic therapy, these bedridden victims were doomed to exhaustion and death, lingering only long enough to develop trophic ulcers over all pressure spots, ascending urinary tract infections and static pneumonias.

At the present time, with modern medical teamwork among the departments of physical medicine, internal medicine, neurosurgery, orthopedics, urology, psychiatry and plastic surgery, these unfortunate patients should expect to be returned to a relatively productive life.

The problem of making life worth living for the paraplegic taxes the skill and ingenuity of the entire team. The efforts to attain this goal should be coordinated by one physician who will carry the over-all objective throughout the patient's life, because it is a lifetime battle to rehabilitate and maintain rehabilitation. Our belief is that the director of physical medicine is best qualified for this work since it falls within his province to train, encourage and watch for early signs of regression in the patient. The slightest neglect will cause a major breakdown and necessitate a long, expensive (in the broadest sense) period of repair before rehabilitation may be started again.

During the Korean conflict there were some cases of paraplegia among military personnel. Because of good early management, these soldiers were returned to the United States in a relatively good condition. The fact that these patients were cared for by specially trained personnel, that their skin and nutritional care was good from the very beginning and that they were rapidly evacuated to the United States made it possible for them to arrive for treatment in good condition and frequently without ulcers.

In civilian practice the plastic surgeon is more often presented with neglected cases because these patients often lie in hospitals or at home for long periods without proper care or instruction. Under such circumstances, paraplegics tend to deteriorate rapidly.

Nursing care does not require a large staff of attendants. One competent nurse can take care of three paraplegics efficiently as part of her daily duties. Considerable time, however, should be spent acquainting nurses and attendants with the problems involved in treating and caring for such patients if complete cooperation is to be gained.

It is impossible to fit patients into a single formula or into a single set of rules. This should be fully realized in caring for paraplegics. The clinical evaluation of the patient is more important than any of the laboratory aids. Patients in a poor state of nutrition will need special therapy before any surgical intervention is instituted. When the regimen is begun, it is advisable to discuss the problem with the patient to give him insight into the situation as well as to gain his cooperation and confidence for the weeks of treatment ahead.

We carry out the following program until surgical care has been completed and the patient is able to leave his bed:

Dietary. A 140 gm. protein, high caloric, high vitamin diet is given to most of the patients. It is frequently necessary to urge patients to maintain a good intake. If the patient is overweight the management of braces is difficult. The weight of these patients is reduced, but at the same time a good protein intake is maintained. Multivitamin supple-

ments are frequently given to paraplegics. Vitamin B_{12}, 25 mg. daily, is given to enhance the appetite.

Hygiene. A daily bath is given with thorough drying of the skin. Massage over pressure areas will aid in preventing ulcers.

Early Treatment of Bruises. Meticulous care in avoiding pressure to a bruised area is of primary importance. The skin over a bruised area must be kept dry at all times. The injection of wydase® twice daily into the venostatic edges of a new bruise will frequently dissipate stagnant blood and preclude formation of an ulcer. This treatment has proved highly successful in avoiding ulcer formation in our series of cases treated this past year.

Bowel Care. An enema is given every other day to those patients who are not already trained. Good bowel care helps to minimize distention which interferes with respiration and food intake.

Bladder Care. Most of the paraplegics are placed on tidal irrigation with buffered citrate solution unless there is a ureteral reflux. Some of the trained patients will evacuate the bladder by suprapubic digital pressure and a few will need suprapubic cystotomy. The catheter is changed at least once a week.

A monthly cystoscopy is done by a urologist until the patient is ambulatory. A sizable bladder calculus may develop in as little time as one month. Early standing helps to avoid urinary tract infection and calculi.

Physiotherapy. The patient is placed on a Stryker or Foster frame and turned every two hours day and night. Some patients can be managed in an ordinary hospital bed but in any case the bed should not be too soft. Oscillating mattresses are not available in most hospitals but would be of value for these patients. Pressure over any bony prominence may start an ulcer in one day's time. Patients should not be kept in bed during their hospital tenure but should be fitted with braces and trained in ambulation as soon as possible. During tissue transfers it may be necessary to confine the patient to bed, but such periods should be kept to a minimum. Early ambulation is important in reducing hospital time and in rehabilitating these patients.

Physiotherapy is carried out daily. The joints of the lower extremities are passively exercised daily. The feet are supported at right angles to minimize the development of foot drop. Active exercise of unaffected muscles, particularly of the shoulder girdle, are instituted so that the patients will be in better condition for ambulation.

Laboratory Aids. A complete blood count is taken once a month, as well as a serum protein test with A/G ratio and a blood urea nitrogen test. Hemoglobin determinations and urinalyses are taken every two weeks. Urine cultures are taken only when there is evidence of an active urinary tract infection. Bacteria are always present in the catheterized specimen.

Medications. An iron preparation is frequently given to paraplegics two weeks of each month. Testosterone, 50 mg. daily, is given for its anticatabolic effect. This produces a decreased excretion of nitrogen, an increased appetite and a general feeling of well-being. Too much medication in the form of pills may occasionally decrease the patient's appetite.

Chemotherapy. This regimen is used as a prophylaxis against urinary tract infections: First week: procaine penicillin, 300,000 units daily; sodium acid phosphate, 1.0 gm. four times daily. Second week: gantrisin,® 0.5 gm. four times daily; sodium bicarbonate, 1.0 gm. four times daily. Third week: methenamine mandelate, 0.75 gm. four times daily.

This chemotherapeutic routine should be repeated until the patient is out of bed and periodic bladder evacuation is established. This regimen is also continued even though another antibiotic may be added during some acute condition. It is common knowledge that within a short time bacteria which infest the catheterized bladder develop a resistance to any antibiotic and for this reason the drugs are rotated at weekly intervals. By alternating sodium acid phosphate and sodium bicarbonate, an attempt is made to alternate the pH of the urine which discourages the rapid multiplication of bacteria. This routine has reduced the incidence of pyelonephritis.

In addition to the routine just presented, there are other substances occasionally considered but seldom used. The estrogens increase the excretion of citrate and reduce the excretion of calcium. In the presence of a urea-splitting organism, the citrate is buffered and its effect dissipated. Hormones should not be administered promiscuously, however, Amphojel,® taken after meals, combines with the phosphates in ingested food, forming insoluble aluminum phosphate which is excreted in the

feces. This reduces the phosphate excretion by the kidney and allows greater reabsorption of calcium. Most patients do not care to take this and it also adds bulk to the diet. Furthermore, with active physiotherapy, less calcium is excreted. An acid-ash diet may be helpful, but most patients also object to this.

While the patient is being prepared for definitive surgery, some attention must be given to the ulcers. The basic care merely consists of thorough cleanliness of the wound and good nutrition. If necrotic tissue is present, the ulcer must be débrided. Devitalized tissue serves as a good pabulum for bacteria. It is not possible to clean up a wound in the presence of necrotic tissue by either the parenteral or local use of antibiotics. It is better to débride these wounds surgically rather than by the use of the slower enzymatic agents. No local applications of antibiotics should be employed unless there is a definite indication for them. All open wounds secrete an exudate composed of tissue fluid containing protein, electrolytes, white blood cells and enzymes. Bacteria are also present but are merely opportunists waiting for the surgeon to commit an error. The wound is not infected until there is a surrounding cellulitis and other signs of infection.

When the patient's condition permits, surgical measures are instituted. The most common sites for ulcers are over bony prominences which have been in contact with the bed or chair. The sacral, ischial and trochanteric ulcers usually command the most attention.

SACRAL ULCERS

In repairing a sacral decubitus ulcer, a retrograde pedicle flap raised adjacent to the ulcer and based on the gluteal circulation is most frequently used. This flap is elevated completely, or nearly so, at the first operation. Color change and marginal bleeding should be carefully observed. In our experience, this flap will not withstand the added embarrassment of being twisted over the sacral area; hence, it is delayed. In about two or three weeks, provided the flap is soft, it is again raised and the sacral decubitus ulcer completely excised. Bleeding may be quite profuse and appears to be controlled best by electrocoagulation in many cases. Needless to say, the blood loss must be replaced. Sacral osteotomy is then performed. The residual soft tissues covering the sacrum are elevated with some difficulty because of the muscle attachments and the irregularity of the sacrum. All bony prominences are removed and the bone is converted into a smooth, somewhat rounded mass. As the patient lies on his back, this rounded bone tends to roll him from one side to the other, provided the sacrum is prominent. The amount of bone to be removed varies with the constitution of the patient. It is necessary to be more radical in the dolichomorphic individual than in the brachymorphic type. The elevated soft tissues are then replaced over the sacrum.

The posterior iliac spines should then be resected. One of these is removed through the donor site of the pedicle flap and the other through an independent incision over the spine. The flap is then rotated into position and sutured into place with a few buried absorbable sutures and cutaneous fine wire or surgical nylon. Because of the difficulty with good hemostasis in this procedure, a drain is placed under the flap and brought out at the lateral base angle. This drain is removed within forty-eight hours. The donor site of the pedicle flap is usually not covered at the time of this operation unless hemostasis has been unusually good. If it is, a drain is inserted at the lateral base angle between the flap and the split-skin graft to minimize the possibility of drainage under the skin graft. The pedicle flap is then covered with a bulky dressing and the turning routine is continued; the patient is permitted to lie on his back for two-hour periods. Within a few days the donor site of the flap is resurfaced with a split-skin graft.

With large ulcers, one such flap may not be sufficient to cover the defect. In such instances a flap may be raised on either side of the ulcer and based caudally. The two flaps then approximate each other in covering the ulcer. (Figs. 1 and 2.) In some of these cases a separation of the flaps over the lower sacrum and coccyx has occurred, and this is undesirable.

In certain cases it is possible to elevate a flap based inferiorly on one side of the ulcer and superiorly on the other, and as the flaps turn in, an S-shaped line of closure develops over the sacrum. Generally, for some of the large ulcers, the transverse pedicle flap on the back above the ulcer, as described by Kostrubala and Greeley, may be better than two flaps based on the gluteal region, since no scar is left over the sacrum by this procedure. (Figs. 3

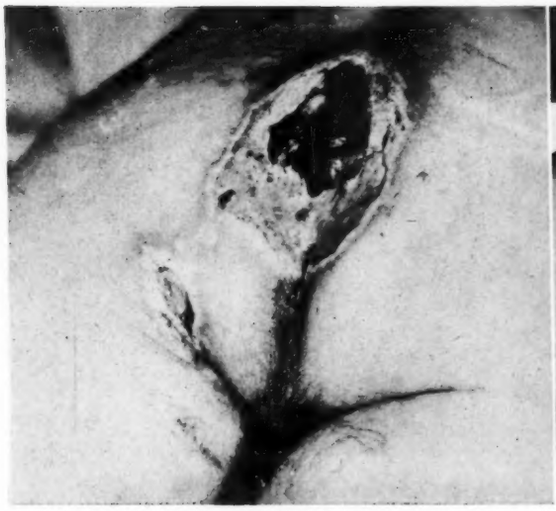

FIG. 1. Sacral and ischial ulcers.

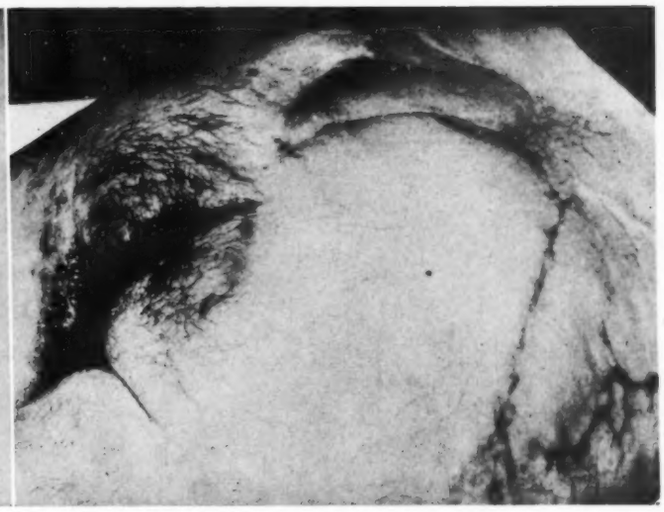

FIG. 2. Closure of sacral ulcer with bilateral flaps. Primary repair of the ischial wound after removal of the ulcer and tuberosity.

FIG. 3. Sacral and ischial ulcers.

FIG. 4. Excision of ischial ulcers and tuberosities with primary repair. Delayed sacral flap.

to 7.) The single gluteal-based flap, when it can be used, is superior to the transverse flap which crosses the midline of the back in that it can be moved more rapidly.

ISCHIAL ULCERS

As soon as it is established that an irreversible lesion exists on the spinal cord, and the patient has been stabilized, resection of the ischial bursa and tuberosity, superior and inferior ramus of the ischium, and the inferior ramus of the pubis should be performed on each side as a prophylactic measure. As the patient spends more time in the sitting position, the incidence of ischial ulcers increases enough to warrant such a procedure. Before ulcers develop, wound healing is better, the closure is simpler and the tissues stand up better under braces.

When possible, primary closure should be carried out following the resection of an ischial ulcer and the underlying bone. (Figs. 6 and 7.) It has been seen that undamaged tissue stands up better under braces than a flap or free skin graft. If the ulcer is large, it may be necessary in some instances to use a flap from the upper posterior part of the thigh. Nevertheless, we have been able to close many large ulcers primarily. In closing the defect left by the resection, regional muscle and subcutaneous tissue should be mobilized to fill the dead space. The muscle and fascia layers are interdigitated, and the suture lines are staggered rather than

FIG. 5. Closure of sacral ulcer with a transverse flap from the back. Repaired ischial ulcers.

FIG. 6. Roentgenogram of patient in Figure 3.

placed one line directly above the other. The wounds are closed while the hips are in a flexed position. If the patient can ambulate with the aid of braces, he should be encouraged to do so within a day or two after the operation. If not, his hips should be passively flexed throughout the postoperative period. Failure to do this makes it difficult to mobilize the hips later. The wounds are drained for two days. Although the wounds are dry at the time of operation and a good closure is accomplished, there is frequently some postoperative bleeding and there may be a persistent serous discharge for a week or longer before the wound suddenly dries up and heals completely.

TROCHANTERIC ULCERS

The ulcer is resected out into normal tissue and the greater trochanter is amputated. If a primary closure cannot be accomplished, an adjacent retrograde pedicle flap is raised on the anterolateral aspect of the thigh and used to close the defect and cover the bone. The donor site is covered with a split-skin graft.

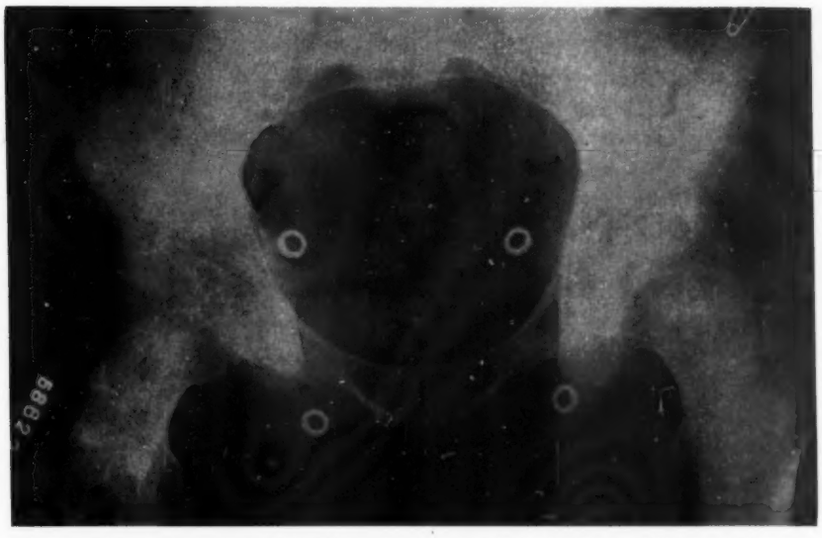

FIG. 7. Roentgenogram following resection of ischial tuberosities and the adjacent bone.

The retrograde flap is advantageous in that the base of the flap, rather than the skin graft, is under the brace.

OTHER ULCERS

The most common sites for decubitus ulcers are those already mentioned. An ulcer tends to develop over any bony prominence which is subjected to prolonged pressure. The basic treatment is the same in all areas. In some situations it may be merely a simple surgical procedure while in others it may be more involved and difficult to accomplish. Large ulcers over the heels constitute a real problem in older patients with limitation of movement in the joints of the lower extremity. In such cases it may be better to try to resurface the area with a split-skin graft. It may not offer ideal coverage, but it is better than scar epithelium.

Throughout the surgical phase of treatment, good nursing care and physiotherapy must be carried out. When the reconstructive work is complete, further attention should be devoted to training the patient to ambulate independently.

Many of these patients must also learn a new trade to earn a living. Our goal is a patient with an intact skin surface, capable of self care, and able to pursue a gainful occupation. We realize that this is the ideal outcome and that it cannot be attained in every patient; some are beyond satisfactory rehabilitation when first seen. Others, in spite of good training, will permit ulcers, urinary tract infections and other complications to develop after they have been discharged, with resultant death. In spite of failures, there will always be the satisfaction of seeing some patients established satisfactorily in society.

SUMMARY

Because of improved medical and surgical care, paraplegics can look to the future with confidence. Their care is a group endeavor, with each specialist playing an important role in the patient's rehabilitation.

The routine care of these patients consists primarily of cleanliness of the skin and decubitus ulcers, good nutrition, prevention of urinary tract complications and physiotherapy. The detailed regimen used to maintain these patients during the surgical phase of their rehabilitation has been outlined herein.

The most common sites for ulcers are the sacral, ischial and trochanteric regions. A retrograde pedicle flap, based on the gluteal circulation, is the one of choice for resurfacing sacral ulcers. The transverse flap elevated above the ulcer on the back seems to be better for some large sacral decubitus ulcers. Because of the increased incidence of ischial ulcers as the patient assumes the sitting position, the resection of the ischial bursa, tuberosity and adjacent bones as a prophylactic measure in paraplegics seems to be justified. Following the resection of any ischial ulcer, primary repair should be performed if possible. A retrograde

flap raised on the anterolateral aspect of the thigh is chosen to close a trochanteric ulcer. The base of the flap, rather than a skin graft, then lies under the brace.

The plastic surgeon is constantly striving to improve his technic for keeping the skin surface intact, enabling the paraplegic to become ambulatory, care for himself, and often make a real contribution to society.

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Psychiatric Aspects of Plastic Surgery

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In all types of reparative and esthetic surgery it is important to evaluate first the lesion from an objective standpoint and second the patient himself in relation to his deformity. "Beauty surgery"—for trivial (or non-existent) defects and those due to excessive or inadequate fat and to aging processes—is usually sought by patients who are self-centered, emotionally immature or maladjusted. Unless cogent economic reasons exist, as in the case of actresses or other public figures, most plastic surgeons are hesitant to perform purely cosmetic operations without a careful study of all the personality factors involved and without psychiatric clearance.

Many patients with basic emotional difficulties have completely unrealistic attitudes toward plastic surgery and demand the impossible. The following excerpts from letters are typical examples: "I am handicapped with large hips. If my figure could be improved, I'm sure I could be a model because I have beautiful hair and features. Unfortunately I have no money, but I would be willing for you to experiment on me . . . " "I am in the army but am very unhappy. I have always wanted to be a girl, and I have read in the newspapers recently that it is possible to have a plastic operation and be turned into a woman. Please let me know how long it will take as I am very eager to have it done . . . " " . . . I am 57 years old but actually I feel and look much younger except for a few wrinkles in my face and neck. My breasts are sagging, and I am troubled with flabby arms and thighs. I am anxious to get married again, and I know that a certain party would be interested if I could be completely rejuvenated in appearance . . . " "I am a girl of 17 and am very sensitive because I am so tall. My boy friend is two inches shorter than I am. I would like to have both my legs shortened with plastic surgery so that I won't be embarrassed when we go out dancing . . . "

Such cases are not hard to screen, at least dissuade from surgery and perhaps refer for proper counselling. Many of these persons are so ready for ventilation therapy that even a partially sympathetic ear is used as an excuse for uninhibited outpourings which embarrass a busy office schedule, to say the least. It is a great mistake to attempt to help them by offering to perform, as an alternate to their demands, some minor cosmetic procedure. We have all learned from experience that such persons will never be satisfied. It is our policy, therefore, to answer preliminary inquiries of this sort with a letter of advice rather than an appointment for consultation.

In the field of plastic surgery the surgeon is often harrassed by patients who refuse to be satisfied after undergoing technically successful reparative procedures. Oddly enough the original lesion, although genuine enough, is usually not actually disfiguring—e.g., a large or asymmetric nose, perhaps, which would be accepted by most individuals as their natural lot. These discontented patients may travel from one clinic to another undergoing repeated surgery until at last they have legitimate cause for complaint and the original personality difficulty is forgotten. A careful preliminary study might have revealed that the large or humped nose or other offending feature was in itself only a symptom of underlying emotional problems, although it might have been blamed for lack of popularity, marital discord, poor business acumen, insufficient artistic talent, poor housekeeping, nervousness, difficulty with in-laws and the like. The surgeon's best protection against this type of patient is a careful photographic record and psychiatric consultation as a prerequisite to operation, both of which may be of medicolegal value.

Although patients with severe untreated per-

sonality difficulties are rarely satisfactory candidates for esthetic surgery primarily, excellent results are often obtained in those already undergoing psychiatric therapy who are referred for relief of congenital or acquired deformities. This is particularly true in those with a fair amount of insight into their problems. Improvement in their outward appearance, even minor rhinoplasties, pin-back of the ears, removal of moles and scars and building-up of the chin, bolsters their ego and makes them believe that something constructive and tangible is being done toward relieving their difficulties.

RECONSTRUCTIVE SURGERY

Untreated or poorly treated congenital defects and facial lesions of moderate or marked severity are associated with profound psychic trauma, and rehabilitation from a physical standpoint alone is far from adequate therapy. The value of medicosocial investigation and the various factors concerned in the development of behavior maladjustments are well discussed in the recent publication by MacGregor and associates.[1] Children are unintentionally cruel in their rejection of playmates on the basis of even minor differences in appearance, behavior and speech; and unless parents and teachers are particularly alert to the problems created by teasing and other types of humiliation, they may remain indifferent or may themselves become either hostile or overprotective. Parents of the handicapped are so often overwhelmed with feelings of guilt, also, that they may fail to provide a stable, secure environment. Family attitudes, duration of deformities and basic personality traits are all extremely important factors in determining the individual reaction to deformity and the ability to form successful relationships with other people socially or in business. The negativistic behavior of strangers—morbid curiosity, prejudice, ridicule, superstition, antipathy in all degrees—is extremely important but is less so than the patient's immediate background, his own interpretation of his deformity and his response to the attitudes of others.

Prevention of the more severe psychologic disturbances associated with congenital lesions and with childhood injuries may be accomplished by early surgery and training and by counselling with parents. In children with cleft lip, for example, we operate as soon after birth as feasible (one to three months of age and over 10 pounds in weight), disabusing the parents of guilt, and advising them to be matter-of-fact in their attitudes and to encourage the child to be outgoing and friendly with other children. At the same time we discuss with them thoroughly the necessity of preparing for proper speech training, using home methods, as soon as the associated cleft palate deformity has been repaired. We believe this procedure should be carried out by the time the patient is two years of age, if possible, in order that incorrect habits of talking shall not become established prior to surgery and that the child shall not be self-conscious about his deformity.

Every effort should be made through public health agencies for proper case-finding and reporting of congenital lesions so that indigent children may be referred to state and other agencies at an early age. Lesions of the face often go untreated through ignorance on the part of the parents that remedial therapy is available, and we are continually surprised to find that congenital absence of the vagina and other genitourinary defects are missed by the examining pediatrician at birth and are not reported by the patient or family until adolescence, when reparative procedures are a matter of serious social consequence. Occasionally pseudohermaphroditic children are brought in at the age of ten or twelve who unfortunately have been raised as the wrong sex and who leave the hospital as "Johnnie Mae" instead of "Johnny" or vice versa. At other times the parents are not willing to give consent for operation or to "changing" of the sex, and in these instances no amount of psychotherapy can resolve the personality difficulties which must develop.

When patients have grown to adulthood or middle age with some type of deformity which has been present for many years, they and their families are prone to hope that a change in appearance will work miracles in other ways. Surgeons must caution them against anticipating too much in the way of cosmetic results (anonymity to the casual observer is usually a feasible goal) and should advocate psychiatric appraisal as an adjunct to surgery in the more difficult cases. Even so it is not to be expected that an introspective, suspicious person will overnight recover from his moodiness and paranoid tendencies and become aggressive, friendly, unselfish, cheerful, understanding and

considerate. On the other hand, patients who have adjusted well to their disfiguring lesions over a long period of time occasionally "blossom out" in spectacular fashion after surgery. In spite of apparent emotional stability they have usually developed patterns of tension, anxiety and self-consciousness which produce fatigue and complaints of lack of energy. Either shyness or over compensatory behavior interferes with normal social reaction and their capacity for constructive use of leisure time.

The reaction of patients to acute injuries depends upon a variety of factors. All of us who did work in plastic surgery centers during the war were impressed, I think, with the high morale of soldiers who received severe facial injuries as contrasted with those who had relatively minor self-inflicted wounds. The latter patients were not necessarily psychopathic cases but were often poorly motivated individuals due to lack of proper leadership and inadequate recreational facilities in the forward areas in back of the fighting lines. Certainly patients with major trauma of the head and neck had in many instances volunteered for difficult and dangerous assignments and, being by nature more aggressive than their companions, tended to adjust to their deformities in a positive fashion. Of a group of fourteen war casualties at Wakeman General Hospital who had complete loss of the lower jaw, all except one or two married during the early stages of their reconstructive procedures, usually to nurses or social workers whom they had not known prior to injury.

In a recent psychologic study of men who emerged as natural leaders in phases of the Korean conflict, Marshall[2] noted that the majority had three factors in common in their backgrounds. They all came from large families, had had religious upbringing and also had had a close companionship with and admiration for their fathers.

The most severe acute mental reactions which we note in civilian practice are seen following extensive burns. Many patients are extremely irritable, very much depressed and even express suicidal desires. Since those with burns of the face appear to be no more affected than those with lesions of the trunk, we believe that the typical response is not related to the fear of disfigurement but is part of the body's response to trauma. As a rule, it occurs first in the second week during the period of maximum nitrogen imbalance and may be combatted by the following measures: high protein, high caloric diet with forced feeding; blood transfusions as indicated; abundant attention and encouragement from all members of the staff; elimination of pain in dressing by the use of analgesia; and as early ambulation and coverage with skin as possible. Patients who have been suffering from chronic open burns with weeping granulations show marked improvement in their mental status with the same vigorous therapy. Psychotherapy is indicated in those with a history of emotional difficulties if symptoms persist for an undue length of time.

Patients with malignancies are often treated by the plastic surgeon, who must take into account not only the resultant cosmetic defect and its effect on the patient but also the impact of the knowledge of cancer itself. We believe that it is a great mistake, however, not to tell the patient the diagnosis. He usually suspects, anyway, and he will have a great deal more faith in the doctor and in his family if the truth is known. Uncertainty is a great deal more devastating to most patients, and we have often found that once informed of the fact that they have a malignant lesion, they become emotionally quite tranquil and are most cooperative and appreciative. At other times they bypass mentally the implication of cancer, as do patients with other diseases which may be fatal, and spend their time fretting about minor ailments such as constipation, poor appetite and rheumatism.

In patients who have undergone mutilating operations for excision of malignancies, decisions with regard to lengthy reconstructive operations should depend largely upon whether or not there has been an apparent cure and upon the patient's age. As a rule, we find it much more satisfactory to fit elderly persons with a prosthetic appliance rather than subject them to repeated surgery. Most young persons appear to prefer reconstruction with their own tissues even though results may be inferior. This is true for both malignancies and for extensive traumatic deformities. We agree, as a rule, except in instances when plastic surgery *per se* has very little to offer.

CONCLUSIONS

Plastic surgery as a science and as an art cannot afford to ignore the psychiatric and

psychologic problems which are associated with congenital and acquired deformities. For purely esthetic procedures the surgeon who investigates carefully both motives and emotional background will insure that his talents will not be wasted and unappreciated. Rehabilitation of the individual with actual disfigurement, whether mild or severe, cannot be accomplished without an understanding of the effect of the specific defects on the patient and on society, and an endeavor to alleviate the tension, anxiety and more serious sequelae of these lesions, even though the results which may be achieved by surgery are far from ideal.

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Dermatome Pliofilm Stamp Grafts

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Twelve years ago we published our original article on the use of small pieces of film-covered skin grafts[1] at the same time that Webster, under whom we were working, published his article on film-cemented skin grafts.[2] We are pleased to report that after following this method for the past twelve years our views have changed very little as to the definite indications for the method, the resultant high percentage of successful "take" on contaminated wounds, the ease of its application and the economy of the donor area, which can be used repeatedly after reasonable intervals of time. One of us (S. B. H.) has found a modified use for pliofilm which will be discussed later, while the other has continued to use the method in its original form.

Since our article was published, others have modified the original procedure, most notably, Reese, who clearly cited his modification of our method.[3]

In reviewing the discussion of twelve years ago, the following points should be mentioned regarding the technic:

1. It is not necessary, as originally stated, to place the grafts 1 cm. apart unless the donor areas are at a great premium and the burned surface is extremely extensive. Placing them 3 to 6 mm. apart allows adequate room for free drainage of serum or other material about the periphery of the grafts, insures a totally healed wound a number of days earlier, and gives a better functional and cosmetic result. (Fig. 5.)

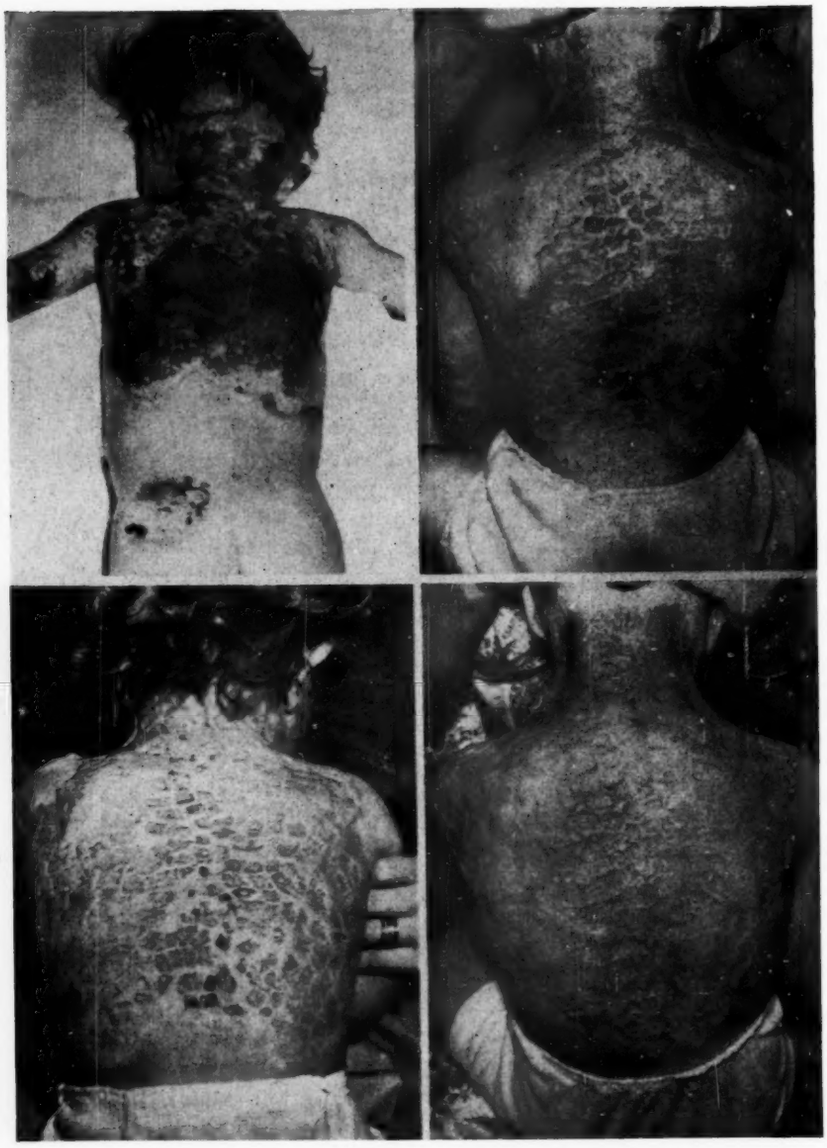
2. It has been found that grasping the pliofilm with film clips, 4 inches wide, to achieve even tension of the pliofilm sheet is highly preferable to grasping the pliofilm in the hands, as originally illustrated, when it is being applied to the dermatome drum.

3. Although there is no objection to the overlapping layer of zinc oxide gauze on the outside of the dressing to hold the moisture, for many years in our actual practice this layer has been eliminated. Nevertheless, there have been instances in which the dressings dried out sufficiently in their deeper layers that in retrospect, we now realize the zinc oxide gauze would have been of real value.

4. It was not originally stated that when these grafts are used to cover a burned extremity it is of great importance to incorporate a plaster of paris posterior or anterior splint to prevent all motion of the extremity, and to maintain a continuous elevation of the extremity to about 30 degrees. We may sum up these two points by saying that the fundamental principles of complete rest to the part accompanied by constant elevation are still the foundation of good postoperative care—principles which we tend to ignore but which we all learned in our earliest days in medical school and which have not been replaced, in our opinion, by some of the more modern concepts.

5. We wish to emphasize that to insure a constant high degree of successful "take" by this method all dressings for the first week or ten days, as outlined in the original article, must be applied either by the operator or by a member of his staff who has the training and the knowledge to prevent any trauma to the young, very delicate grafts during their first days of existence. Delegation of the rather unstimulating and time-consuming task of changing these early dressings to an inexperienced doctor or nurse will most certainly spell defeat. This unfortunate error in judgment has been observed.

Our original opinion still holds true in that " . . . We feel that the method of applying grafts according to the technic which we have described is the method of choice in extensive third degree burns where the donor areas are at a premium, and also in those cases of extensive third degree burns where multiple burned



1A 1C

1B 1D

FIG. 1. A, Photograph taken January 19, 1952, the eleventh day after patient received third degree burns to the back and neck. B, appearance of patient on November 27, 1952, ten months postoperatively. The grafts in this area "took" almost 100 per cent, having been laid on granulation tissue. By March 19, 1952 (less than two months after patient was burned), the area began to be very itchy and show hypertrophic scar. Within four and a half months of the operation there was considerable irritated scar hypertrophy. Therefore, a mild course of 400 r radiation was given in divided doses of 100 r and completed in the next two months (August 7, 1952), Presbyterian Hospital formula.[13] No further x-ray therapy over this wide area was planned because of the danger of injury to the epiphyses of the spine in this young child. C, appearance of patient on May 13, 1953, one year and three and a half months postoperatively and eight and a half months after course of 400 r radiation in divided doses of 100 r every two weeks. D, appearance of patient two years and seven months postoperatively and two years after course of radiation. Area is now no longer itchy or red.

FIG. 2A. Photograph taken July 5, 1955, of right anterior thigh of patient M. M., a six year old girl. Donor site for pinch grafts to cover small area of graft loss following extensive skin graft for almost total avulsion of skin of dorsum of right foot and ankle sustained in serious car accident. Patient was treated by a general surgeon, with exceedingly fine "take" of entire area except the small area for which these grafts were taken.

FIG. 2B. Same patient. Photograph taken January 13, 1955, of dorsum of right foot and ankle. Dorsum of right foot shows excellent "take" of original dermatome graft at emergency operation by a general surgeon, and subsequent coverage of small area of loss with pinch grafts from site in Figure 2A.

areas are involved and the patient's general condition does not permit prolonged grafting procedures where the granulation tissue is excised and the grafts are applied and sutured into position in the usual way."[1] In a very ill patient, grafts may be cut to the limit of the tolerance of the patient, refrigerated and applied at a later date either at the bedside or in the operating room without anesthesia.

We believe that the small grafts of Reverdin[4] and the small deep grafts of Davis[5] were a great contribution in their day and filled a very necessary and useful purpose. However, with the advent of the dermatome by Padgett in 1939[9] and its many fine modifications since, both manually and electrically operated,[2,7–12] there is now almost no place for the small deep grafts. This statement is made because not only is the donor area from which the small deep grafts are taken cosmetically unsightly and destroyed forever in terms of further use but also the grafts with their "pebbly surface" are more unsightly than the pliofilm dermatome stamp grafts. (Fig. 2.) In the latter grafts, the donor areas are not unsightly and are available for reuse if necessity demands.

We still believe, as stated originally, that pliofilm stamp grafts are inferior cosmetically to the large dermatome skin grafts, and should not be used when the latter can be applied consistently with a high percentage of "take." However, the late results can be quite satisfactory, as illustrated in the case report. (Figs. 6 and 7.) On the other hand, they can also be unsatisfactory in spite of practically 100 per cent "take" of the original grafts, with resultant hypertrophic scars arising between each individual graft. (Fig. 1.) We know of no way to prognosticate this type of result. We believe, therefore, that the indications for this type of graft are limited.

We are still in accord with our earlier opin-

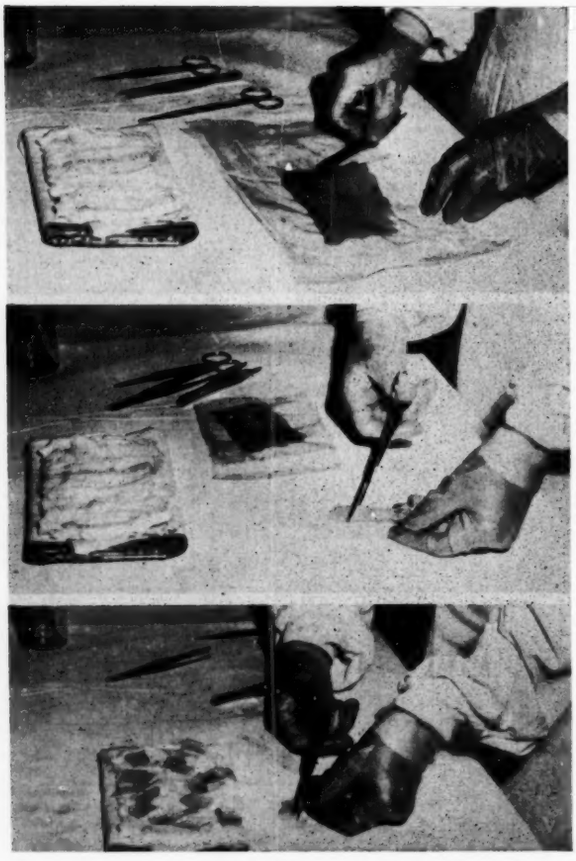


FIG. 3. Top photograph illustrates spreading of split-thickness skin graft on pliofilm backing after graft was cut with an electric dermatome. Middle and bottom photographs show sectioning of the graft with pliofilm into postage stamp size, maintaining skin tension.

FIG. 4. First photographs taken on admission, September 6, 1947, six weeks after patient was burned. Patient was transferred at that time from another hospital.

ions on the advantages and disadvantages of using the pliofilm stamp grafts; they are as follows:

Advantages. As the skin grafts are stretched on the pliofilm at normal skin tension, there is no opportunity for the grafts to undergo troublesome curling about their edges. This results in a very great saving of time in comparison with the method in which pliofilm is not used. The large time factor involved in the cutting up and application of stamp grafts from sheet grafts without any form of backing prompted us to develop our method. One might say that "necessity proved the mother of invention."

"There is a much larger percentage of 'take' in comparison with any form of large split thickness sheet grafts in an infected field. There is an unusually good opportunity for free drainage about the periphery of the grafts, which is a great advantage over any form of sheet graft as these wounds are at least bacteriologically dirty, and demand adequate drainage."[1]

If the patient's condition is very poor, general anesthesia is necessary only for the actual cutting of the grafts.

The donor sites are not destroyed and can be used again, if necessary, because of the thinness of the grafts; and they are vastly superior cosmetically to the donor areas of small deep grafts.

"The cosmetic appearance of the 'postage stamp' graft, although inferior to any form of sheet graft, appears to be equal, if not superior to that of the small deep grafts."[1] From our experience, we can now say that the cosmetic appearance of pliofilm dermatome stamp grafts is vastly superior to that of small deep grafts. (Fig. 6.)

Disadvantages. Dermatome pliofilm stamp grafts are cosmetically inferior to dermatome sheet grafts, and more scarring results from their use.

"It is true, more time is consumed in cutting

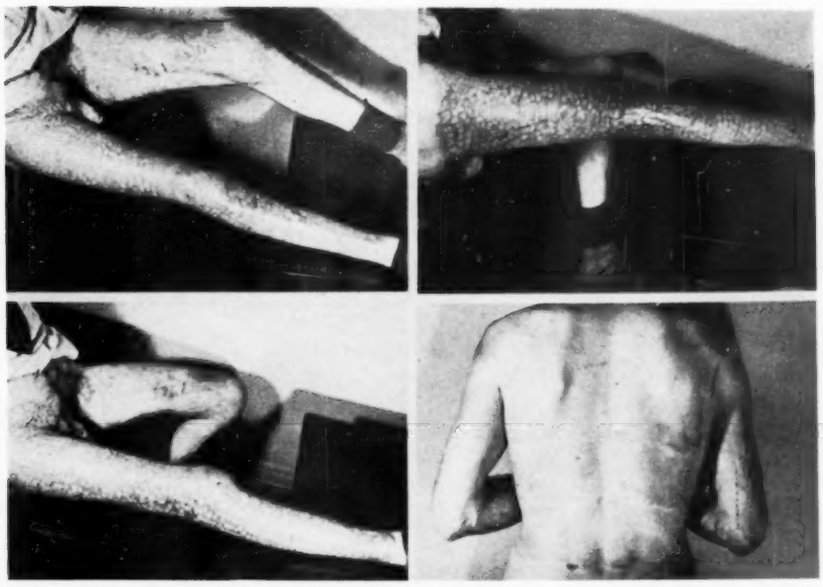


FIG. 5. Same patient as Figure 4. Second photographs taken on November 6, 1947, two months after the first operation. Note the prominent mosaic appearance at this early stage, and also that the grafts are placed considerably closer together than was suggested in our original article. Donor area of entire back is satisfactory even at this early stage (two months postoperatively).

the graft because of the application of the pliofilm to the drum, which may be considered a disadvantage. However, the ease and rapidity with which the grafts can be applied more than compensate for this time."

One of us (S. B. H.) has developed the following modification for the use of pliofilm split-skin grafts. After the graft is cut with an electric dermatome or a Blair knife, the skin can be spread over the surface of the pliofilm to re-establish the skin tension. The skin spreads readily over the pliofilm when a blunt instrument such as a knife handle or the back end of a tissue forceps is used, starting from the center of the graft and working toward the periphery. The sheet of skin can then be cut into stamp grafts with the pliofilm in position, thus maintaining the skin tension and facilitating the handling of the stamp grafts which are applied as outlined in the original article. Care must be taken not to use a weight of pliofilm which is too thin since the elastic recoil of the skin will curl the pliofilm with it. This difficulty will not be experienced if the pliofilm is of sufficient weight to overcome this elasticity. It is advisable, sometimes, to coat the pliofilm with a thin layer of vaseline, certainly when thick-split grafts are used, to maintain better adherence between the pliofilm and the skin. (Fig. 3.)

CASE REPORT

D. H. F., a twenty-five year old white man, sustained simultaneous electrical and fire burns on July 29, 1947, when water-well drilling equipment contacted high tension wires. He was admitted with extensive third degree burns on the right groin, the right lower extremity from the groin circumferentially to the ankle (with the exception of the area over the patella), the right forearm, the left groin, penis, scrotum, right gluteal region and right lower anterior abdominal quadrant. (Fig. 4.)

The first operation was performed on September 8, 1947. With the patient on his stomach, eight full drums of skin, 0.010 inch thick, were cut from the back on pliofilm. This stripped the back of skin from the nape of the neck to the iliac crests caudally, and to the mid-lateral lines laterally. All the burned areas, with the exception of a good part of the calf and shin, were then covered with the eight drums of skin, after they were cut into postage stamp grafts.

Seven days later, on September 15th, the second operation was performed. Three drums of skin were taken from the left thigh; two of these were applied by the method described and the third was refrigerated. As the "take" was complete, it was not needed.

There was almost 100 per cent "take" from

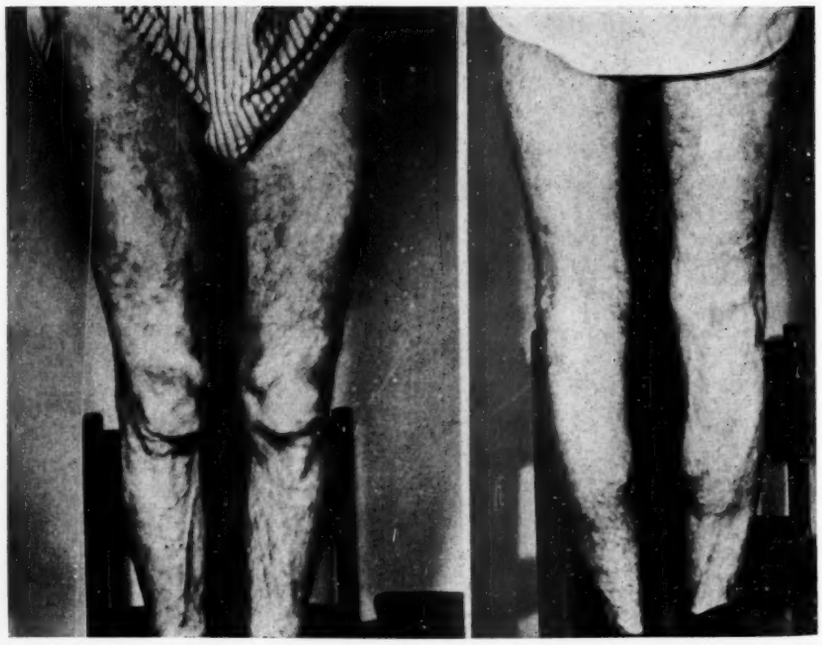


FIG. 6A. Same patient as Figure 4. Photographs taken October 19, 1950, three years and two months postoperatively. Note the excellent appearance of the grafted right leg compared with the normal left. The great saphenous vein is prominent beneath the grafts.

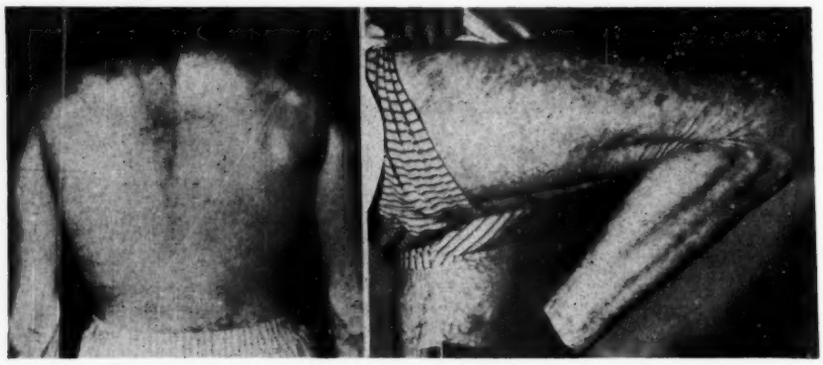


FIG. 6B. Same patient as Figure 4. Photographs show the excellent appearance of the final donor area on the back, and the normal range of movement of the knee.

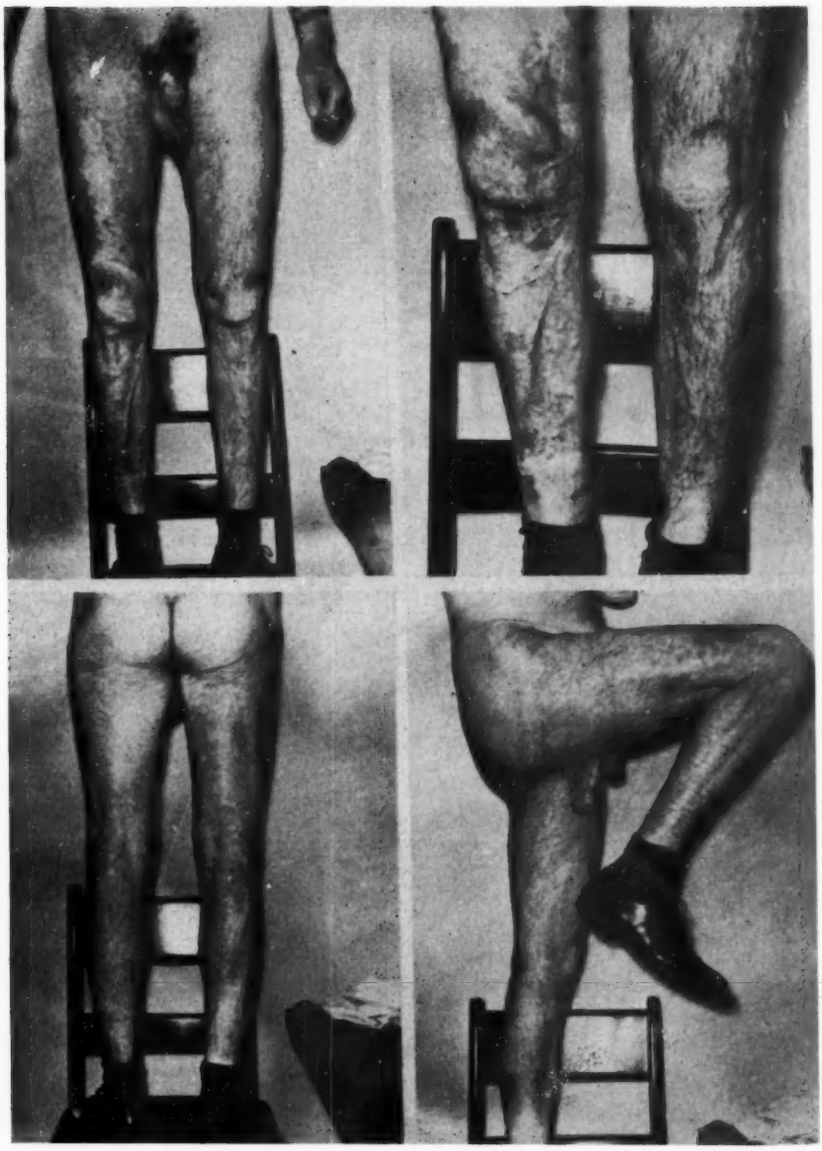
both sets of grafts. (Figs. 5 and 6.) The operator recalls approximately only three individual grafts that did not "take." The areas grafted at the first operation were almost healed in ten days. Dressing care followed was as outlined in our first paper.

The patient was very cooperative, and for one year postoperatively he consistently wore an elastocrepe (Ace) bandage below the knee and one above the knee at all times that his leg was dependent. Each day these bandages were replaced by freshly washed ones to restore the natural elastic tension to the weave of the bandages. These four bandages used on alternate days were still efficient after one year's use.

We believe that this rigid postoperative control, which started with one minute dependency per hour per day and increased by one minute per hour per day by actual clock, is essentially responsible for the permanent successful outcome of this patient's results.

A recent postoperative follow-up examination revealed that this twenty-five year old man has now progressed eight years uneventfully since his extensive burns (mainly on the right lower extremity and lower abdominal

7A



7C

7B

7D

FIG. 7. Same patient as Figure 4. Photographs taken July 3, 1955, almost eight years postoperatively. Patient has had an entirely uneventful experience with his grafted right lower extremity and other areas referred to. A, anterior view of grafts to right lower extremity, both groins, right lower abdominal wall, penis, scrotum and right forearm. B, posterior view. C, anterior close-up showing smoothness of grafts, lack of mosaic appearance and prominence of normal veins beneath graft. D, right profile view showing normal movement of right knee.

wall) were covered by ten dermatome drums of skin applied according to the method of the original article. (Fig. 7.) He has worked daily, spending much time on his feet. He states that his only complaint is a severe aching in his right lower extremity, mainly behind the knee, when he becomes very tired, upset or worried. This is a very interesting observation and one which we are unable to explain. He has not worn an elastic support since it was discontinued after the year of continual wear following grafting.

SUMMARY

A twelve-year follow-up on the use of dermatome pliofilm stamp grafts has been presented.

Other uses of pliofilm in connection with split-thickness skin grafts are included.

Acknowledgment: We wish to thank Miss Sylvia Cranston and Mrs. Dorothy Halphen for their help in the preparation of this paper. We also wish to express our appreciation to Mr. Joseph Bochsler for his work in the preparation of the photographs. The pliofilm referred to in the article is a Goodyear product.

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Congenital Webbing of the Neck (Pterygium Colli)

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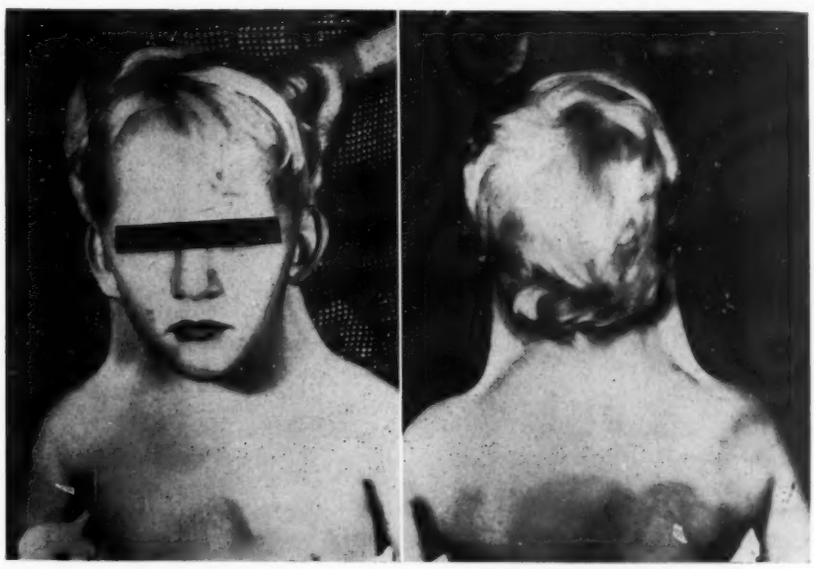
THE surgical literature on congenital webbing of the neck has been somewhat scanty since Kobylinski[1] described this condition in 1883. Chandler[2] in 1937 reviewed the literature and found many diverse opinions as to the etiology, from an atavistic phenomenon related to the higher apes, to endocrine dysfunction. He was the first on record to describe the surgical correction of the deformity by transposition of triangular flaps or Z-plasty.

In 1938 MacCollum[3] published a very comprehensive report on a study of four cases and several fetuses, and proposed an excellent theory on the embryonic development of these webs during the period when the neck is formed. His outline of surgical treatment is concise and clear, with excellent diagrams to illustrate the technic.

In 1946 Bettman[4] included "the shoulder girdle" in the title of his article on congenital bands, rather than limit the bands to the neck alone. He reported four cases of webbing of the neck and two of axillary webbing. His cases were of particular interest in that two patients were males, whereas in most of the cases seen patients are predominantly female.

It is difficult to analyze the incidence of the deformity because of some confusion in the reports. MacCollum[3] states that "approximately twenty patients with congenital webs of skin extending from the mastoid process to the acromial process" were reported on from 1883 to 1938.

Our search of the literature reveals approximately seventy-five to eighty cases up to the present time. The more recent textbooks on



1A 1B

FIG. 1. Case 1, patient K.T. A, shows this ten year old white girl with congenital webbing of neck; note shortness of stature. B, illustrates the wide webs extending from the mastoid to the acromion process.

FIG. 2. Case 11, patient M.S. A to D, note webs in relationship to hair-bearing areas, apathetic facies in contradistinction to alert mentality. This patient had proved agenesia of ovaries by skin biopsies. E and F, patient after surgery.

plastic surgery rarely mention this anomaly *per se*, whereas other more common deformities or malformations are noted in detail. Whether or not the simplicity of the correction of the webbing makes it less interesting from a surgical standpoint or whether the rarity of its occurrence is at fault, the anomaly is usually omitted.

The subject has not been forgotten, however. Since the discovery that biopsy specimens of the skin reveal specialized chromosomal sex chromatin in females (rarely encountered in males), the interest in these cases has become widespread among endocrinologists, gynecologists, psychiatrists, pathologists and other specialists. This is particularly due to the fact that in most of these cases other deformities are concomitant. In the three cases seen by the author, all of the patients were females and all had the characteristic foreshortened, dwarfish bodies, looking more male than female. Denying their apathetic facies, they were all exceptionally alert mentally and none had cleft palates or clubfeet. Histopathologic examination of the skin in the more recent case (patient M. S.) showed the predominance of male sex chromatin. The first case seen by the author was one in which the webbing extended from the region of the buttocks to the posterior calf and contained the sciatic nerve. Unfortunately the records have been lost since the death of the surgeon whom the author assisted.

The two patients reported on herein had, as is shown in Figures 1 and 2, true webs from the acromion to the mastoid which were made up of skin and subcutaneous tissue only. No muscle, large vessels or nerves were encountered.

Both girls had the typical signs of ovarian agenesia, which syndrome has been described by various authors including Varney et al.,[5] Albright et al.[6] and others.

The syndrome usually consists of five characteristics: (1) primary amenorrhea; (2) failure in the development of primary and secondary sexual characteristics (although normal development of the breasts occurs in some cases);* (3) increased urinary gonadotrophin titer; (4) short stature; (5) associated congenital anomalies of which, according to Turner,[7] webbed neck, cubitus valgus and aortic coarctation are most frequent.

The maldevelopment of the genitals consists of a rudimentary uterus, small but usually complete fallopion tubes, atrophic external genitalia and ovarian anlagen. The pubic hair is limited to the vulva and the lower mons. These cases have stirred the interest of the various specialists mentioned and the literature is abundant on their findings. No doubt the plastic surgeon has corrected many cases in which the dwarfism and agenesia of the ovaries have been overlooked in the problem of reconstructive measures. It is for this purpose that an attempt is made to bring the entire picture to the attention of the plastic surgeon in order that these children may receive complete care.

The correction of the deformity consists of a large Z-plasty, the Z being shaped so that the flap bearing the greatest amount of hair will be transposed behind the ear and the hairless flap transposed to the lower neck region. Often it may be necessary to make some secondary excisions of hair-bearing skin in order to produce the desired result. The upper leg of the Z should follow the line of the jaw and the lower leg should extend backward and slightly upward from the acromial end of the web toward the posterior midline of the head. The usual postoperative care and dressings are necessary.

* See Bettman's case 1, Figure 3, page 209.[4]

SUMMARY

Two cases of pterygium colli are presented.

The endocrinology associated with the deformity is discussed and a plea is made for complete care of these cases.

The embryologic theory of etiology has been discussed elsewhere and is not included.

Suggestions are offered as to the placement of incisions for corrective surgery.

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Immediate Closure of Skin Defects about the Head and Neck

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THE average surgeon whose practice includes traumatic and reconstructive surgery is probably seeing more opportunity for closure of facial defects today than at any previous time. This is due to the increase in the number of accidents—both highway and industrial—and to the increased amount of radical surgery for malignancies about the face.

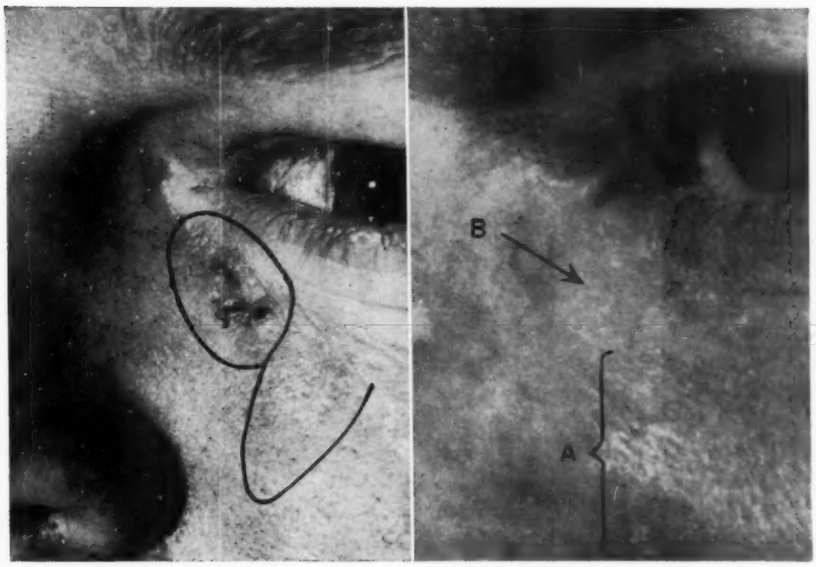
The refinement of surgical technics and the availability of effective antibiotics have each played a large part in the effectiveness of applied skin grafts, and this has been thoroughly described in the literature. However, there has not been a corresponding amount of emphasis on the use of local tissues for repair of skin defects.

The chances for survival of an advancement or rotated pedicle flap in the region of the face are much better than they would have been twenty years ago. This is due in part to the vast experience obtained during the war in the plastic surgery centers as well as in the more remote and smaller hospitals. It is also, of course, due to a great extent to the increased ability to control infection that has been given us by the development of the various antibiotics.

It is the purpose of this paper to call to the reader's attention the possibilities of local advancement and rotated flaps and to illustrate with examples the results that can be obtained with their use. Since the pedicle flap is obtained from adjacent tissue that is more similar than tissue brought from a distant area by split-skin graft technics, it matches more closely the skin that eventually surrounds it, and in addition heals with far less scarring,

1A 1B 1C

FIG. 1. A, basal cell carcinoma of nine months' duration was completely excised and the border checked by frozen section and found to be free of involvement. The pedicle flap used to close the circular defect is outlined in the photograph, lying below and posterior to the lesion. B, two weeks after operation the line of closure of the donor site appeared as in (A) and the rotated pedicle flap is in its new position as indicated by (B). Further revision of the flap edges and angles was necessary. C, two months after revision of the angles of the flap to obtain a more nearly normal contour.



2A 2B

FIG. 2. A, basal cell carcinoma below left inner canthus of two months' duration. The lesion was excised as indicated by the circle, and a flap was elevated as indicated to be rotated into the defect. B, the closed donor site of the pedicle is indicated by (A); the healed pedicle by (B).

giving a result that is much more satisfactory cosmetically than the graft technic. (Figs. 1 to 3.)

DIRECT ADVANCEMENT SKIN FLAPS

When proper technics are used to prevent trauma to the flaps which are elevated adjacent to skin defects and proper antibiotics are given to control infection, it is quite often possible to close wounds primarily which would previously have been considered able to be closed early only by skin grafts. It is very important in the handling of these wounds that the necrotic or jagged edges of the defect be thoroughly excised in such a manner as to leave perpendicular and uniform borders to the defect. It is further important that the undermining contain an adequate subcutaneous layer of soft tissue. This usually is a layer that is from one to three times the depth of the skin itself in thickness. Undermining should be gentle and by sharp dissection. The use of a "spreading scissors" type of blunt dissection technic for elevation of the flaps usually results in less immediate bleeding, but quite often produces enough bruising to the blood supply of the flaps to interfere markedly with optimum healing. The skin edges themselves should be handled with fine hooks and not with tooth forceps or other clamping technics.

After the sides of the defect have been undermined widely enough, the skin is stretched until the two edges of the defect meet and the edges are approximated with an interrupted subcuticular suture so placed that the knot is beneath the skin. For this purpose the most satisfactory material has been found to be fine white nylon. Since this material is seldom extruded (and when it is extruded, it is extruded dry and not through a pustule), it serves to keep the wound edges in approximation permanently rather than allowing later thinning and spreading of the scar. A superficial layer of sutures which are used to approximate the skin edges in a more accurate "leveling" process can be applied for a few days if needed.

THE ROTATED FLAP PEDICLE

However, many wounds are seen about the face which are too large to be closed with the advancement flap described. Many of these can be taken care of quite satisfactorily by means of the rotated pedicle flap. Quite often it is possible to use several of these rotated flaps to fill in defects in adjacent areas in either the same stage or in multiple stages.

It should be pointed out that the undermining technic described heretofore should be used in elevating these flaps, but in addition the following points should be observed:

1. Whenever possible the flap should orig-

3A 3B

FIG. 3. A, basal cell carcinoma of the nose which was widely excised and then closed immediately with a rotated pedicle flap obtained from the right nasolabial fold. B, the flap has healed without gross distortion of the nose, and the donor site of the flap lies in the normal nasolabial fold angle.

inally be outlined in such a direction as to include all possible blood supply to all of the areas of the flap.

2. The flap should be outlined in a manner that will keep it continually increasing in width from tip to base so that all of the edges of the flap are receiving an adequate blood supply.

3. When the flap has been elevated and then rotated, the flap should be observed for several minutes to determine the effect of rotation upon the blood supply. If the rotation has obviously changed the blood supply to a point where the flap will not survive, the flap should be placed back into its original position to allow it to build up a better blood supply. The signs of these changes which are indicative of interference with the blood supply are: (A) marked blanching, due to the interference of the arterial supply; (B) the change in color to a "blue-black" appearance which indicates interference with the venous drainage of the flap and which, while not as serious as the blanching sign described previously, will still often be indication enough for return of the flap to the original site.

In both of these technics it is important that the postoperative care of the wounds be carefully maintained. This includes adequate support to the wounds after removal of the sutures, as well as protection of the wound from any chafing or scraping, or scratching action to which it may be exposed. The most satisfactory method of protection in our hands has been the application of strips of a 1 inch roll of bandage across the wound which are then painted with U.S.P. collodion and allowed to dry. These contract in drying and hence hold the wound edges firmly in apposition, and in addition form a shell-like protective covering to the wound. The use of antibiotics in these cases as a prophylactic measure is justified, for a very small amount of infection working for a short while can produce quite marked disfigurement in these patients.

SUMMARY

The consideration of the use of local advancement and/or rotated pedicle flaps in the closure of skin defects about the face is reviewed. The advantages of the end result of these procedures over the use of split-skin grafts are pointed out. Examples of varied applications of these flaps are submitted.

End of Special Number on Plastic and Reconstructive Surgery

SURGICAL REVIEW

Burns

AN OUTLINE FOR TREATMENT

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A BURN is considered a problem in colloid, electrolyte and water balance due to a shift of the extracellular fluid resulting in a state of acute internal dehydration.

The primary aims in the treatment of burns are: (1) prevention and treatment of shock, (2) prevention and treatment of infection, (3) utilization of a local therapy that will insure drying of the burn wound and permit early skin grafting, (4) maintenance of adequate nutrition and hemoglobin level during the healing stage, and (5) prevention and correction of contractural deformities.

The treatment of burns demands the knowledge of normal physiology, pathologic physiology, cardiovascular dynamics, bacteriology, endocrinology, nutritional balance and plastic surgery.

NORMAL PHYSIOLOGY

The vital function of the circulation is carried out in the capillary bed. The accumulation of metabolites plus a decreased oxygen tension in the tissues initiates capillary activity and so regulates the oxygen supply to the tissues. Normal fluid balance is maintained by the following factors:

1. The hydrostatic pressure and filtration of water from the arterial end of the capillary, and the osmotic pressure in the venous end causing a re-entry of an equal amount of water. Water and electrolytes permeate the capillary wall. The plasma proteins cannot permeate the capillary wall, but influence the distribution of water and electrolytes between the intra- and extravascular spaces. The osmotic pressure will depend on the concentration of the intravascular proteins. A diminution will be followed by a shift of water and electrolytes until a new equilibrium is established.

Diminution of plasma protein concentration causes a diminished return of fluids due to the lowered osmotic pressure, thereby resulting in an accumulation of fluid in the extravascular spaces.

2. The proper ratio of intracellular potassium and extracellular sodium. The potassium is more or less fixed within the cell, so that the distribution of water is influenced by the extracellular sodium. An excess of the sodium ion will cause retention of water in the extracellular space resulting in edema. A deficit of sodium ion results in an intracellular edema and an extracellular dehydration. The blood volume and capillary circulation therefore depend on adequate cardiac output, normal arteriolar constriction, normal distribution of electrolytes, normal concentration of plasma proteins and physiologic reactibility and permeability of the capillary wall.[1]

PATHOLOGIC PHYSIOLOGY

A burn results in varying degrees of necrosis followed by a chain reaction of altered body physiology. This includes pain, increased capillary permeability, alteration in blood flow,

sludging of the blood, hemoconcentration and ultimately shock.[2]

An understanding of the pathologic physiology is essential since rational therapy is based on the changes induced by thermal trauma.

Burns increase the permeability of the capillary membrane permitting water, electrolytes and protein to escape from the intravascular space. The loss of blood volume and the increase in the viscosity of the blood reduces the efficiency of the circulation in its function of carrying oxygen to the tissues. Tissue hypoxia, increased capillary permeability and loss of plasma-like fluid through capillaries becomes generalized, whereas at the onset it is confined to the burned area.[3]

Hemoconcentration. Hemoconcentration may occur in burns involving more than 5 per cent of the body surface.[2] There is an increase in the red cell concentration in the remaining plasma reflected by a rise in the hematocrit. As the hemoconcentration increases, agglutination of red blood cells takes place, with formation of small emboli of erythrocytes which may lodge in the terminal capillaries. In spite of the apparent concentration, red cells are lost, resulting in a decrease in the circulating red cell mass. Red blood cells are lost by destruction in the burn area, increased fragility, stagnation in the capillary bed and sludging.[4] Hematocrit readings do not reveal hemoconcentration until three to six hours after the burn occurs.[5]

The hematocrit level is not always reliable in an extensive burn, as there is hemolytic destruction of red cells with a large proportion of red cells being trapped in the capillary bed. Should the red cells be lost from the circulating blood as rapidly as plasma is leaving it, the hematocrit will not rise. Red blood cells as well as plasma are lost from the circulation at the burn site. The hematocrit may be normal whereas the circulating blood volume may be reduced.

An elevated hematocrit infers that the plasma volume has been reduced more rapidly than the red cell volume, but does not infer that plasma alone has been lost from the circulation.

Edema. The intra- and extracellular fluid represent body compartments. The extracellular fluid can be divided into the intravascular (plasma) and the extravascular (interstitial) spaces. The area of burn edema represents an abnormal third compartment, the result of increased infiltration from damaged capillaries.[6] In a severe burn, the local area may accumulate as much as 10 per cent of the body weight or one-half of the total extracellular fluid.

There is a sudden shift of fluid resulting in an acute depletion of the intra- and extravascular compartments, which are sacrificed to form the edema of the burn area. The amount of circulatory plasma and interstitial fluid is greatly reduced.

The burn area contains a large amount of edema fluid which contains electrolytes essentially those of extracellular fluid composition with protein that has leaked through the damaged capillary walls. The protein and electrolytes in the edema fluid are lost to the body economy.

Cope[7] has described the burn wound as a "parasite on the surface of the body." The wound, like a leech, sucks water, protein and electrolytes from the plasma circulating through its depths, and it swells with edema. In extensive burns there is an increase in the underlying pressure which forces the edema fluid into the lymphatic channels.

Shock. Burn shock is manifest by: (1) thirst, (2) rapid pulse, (3) reduced pulse volume, (4) falling blood pressure, (5) signs of vasoconstriction (cold extremities, ears and nose), (6) collapsed veins and (7) mental change.[8]

Shock therapy depends on the maintenance of the circulatory blood volume and the normal relationship of the intra- and extravascular compartments. The restoration of the blood volume will prevent liver, kidney and cerebral damage.

Mortality. Respiratory deaths may occur in the first day, fluid and electrolyte deaths from the second to the eleventh day, fulminating infection from the eleventh to the thirteenth day, and fulminating serum hepatitis in the later stages.[9]

IMMEDIATE EVALUATION OF THE PATIENT

Age and Physical Conditions. The young withstand burns better than the aged due to the greater stress response.[10] The condition of a child with a burn covering 20 per cent or more of the body surface is considered critical, whereas an adult with a burn covering 30 per cent or more of the body surface is considered in critical condition.[11] Burns involving 30 to 45 per cent of the body surface in patients over the age of sixty are invariably fatal. People over

sixty years of age may die from causes not related to the burn.[12] Anemia, generalized arteriosclerosis, cirrhosis, cardiovascular and renal disease make it difficult to plan fluid and electrolyte therapy for the aged group.

Respiratory Tract Burns. Burns of the respiratory tract are usually caused by hot, irritating gases and may involve the nasal, buccal, pharyngeal and laryngeal mucous membranes as well as the entire tracheobronchial tree. Intravenous fluids are given in minimal amounts to avoid pulmonary edema. A high humidification of the room is beneficial. A 3 per cent cocaine spray may reduce the glottic edema. Suction is instituted for the removal of exudates, and oxygen is administered for anoxia. A tracheotomy set is held in readiness.

Extent of the Burn. The prognosis varies directly with the type of burn, intensity of the heat, duration of the exposure, and extent and depth of the burn.

The extent and depth will vary with the type of apparel worn. Cotton, linen and viscose rayon are highly inflammable, whereas hairs and silks are non-inflammable.

The clothing must be removed so that the extent of the burn can be charted and the weight estimated. A deep burn involving more than 50 per cent of the body surface is usually fatal.[13] There is a tendency to underestimate the depth and overestimate its extent.

Various charts have been devised to estimate the extent of burns, the most accurate being that of Lund and Browder. A modified Berkow table, "The Rule of Nine" is a convenient measure for emergency use in adults.

Depth of the Burn. The simplest classification as to depth is partial and full-thickness burns. Differentiation may be difficult in the early stages. Infection may convert a partial burn to a full-thickness burn.

Converse and Robb-Smith[14] have suggested the division into epidermal, dermal and deep burns. The following is a combination of the commonly accepted classifications.

SUPERFICIAL BURNS (PARTIAL THICKNESS)

First Degree Burns (Epidermal). This type causes a mild erythema. There is dilatation of the capillaries and edema of the skin with desquamation of the superficial part of the epidermis.

Second Degree Burns. Dermal burns: Blistering is due to an epidermo-dermal separation produced by the exudation of fluid. There is a loss of the epidermis and varying parts of the dermis.

When the base of the blister is red, smooth and moist, healing may be expected in seven to ten days unless infection occurs. Epithelization originates from a few remaining islands of basal epithelium and from the hair follicles and sweat glands.

When the base of the blister is gray and dry, the dermis is more deeply involved and healing will be slower because a layer of burned dermis must first be eliminated as a slough.

Deep dermal burns: With this type there is destruction of the dermis down to the deeper layers. A thicker layer of dermis is destroyed, exposing the base of the dermis which appears grossly punctated. There are numerous small islands of epithelium from which epithelization spreads as a pearly white, thin layer. The healed epithelium is often thin, parchment-like and prone to cracking.

DEEP BURNS (FULL-THICKNESS)

Third Degree Burns. The entire thickness of the skin is involved with destruction of all the epithelial elements, so that natural healing occurs by epithelial cell migration from its edge and contraction of the burn wound.

Full-thickness burns may present any or all of several appearances in close juxtaposition: black or dark brown leathery char, dead white cadaveric, deep pink with thrombosed vessels which do not blanch on pressure, heavy desquamation with thin roseate pink beneath, and transparent with a network of thrombosed blood visible in the corium. An extensive flame burn or scald may be assumed to be largely third degree with little likelihood of error.[15]

Many criteria have been explored, such as the fluorescin test for the presence of dermal circulation and staining reactions of the surface of the burn to show up the area of dermal necroses.[16]

Sensitivity of the burn to pinprick infers partial skin loss, whereas loss of sensation signifies full-thickness loss. Analgesia may be present in superficial burns caused by acids and alkalies.

Most burns and scalds are deepest in the center and most shallow at the periphery, so that the appearance tends to be one of concentric zones.[17] Burns from molten or red hot

metal usually cause full-thickness loss. High temperature liquids usually cause mixed lesions. Acid burns frequently cause partial-thickness skin loss, even though they may be white and analgesic after the injury.

Partial-thickness skin loss may result in a red, raised and moist appearance of the skin.[18] Sufficient living epithelial elements are present to resurface the area. Full-thickness skin loss may result in a white, depressed, dry and painless appearance.[19]

SYSTEMIC TREATMENT

Preliminary Examination. (1) Estimate weight; chart type, intensity, extent and depth of burn. (2) Draw blood for baseline examination: insert polyethylene tube and start colloid infusion before venous collapse occurs. Children may require the use of an intrasternal needle.[20] (3) Record intake and output of fluids: insert a Foley catheter to measure the output. The hourly urinary output will determine the adequacy of fluid and electrolyte balance; chart emesis volume. (4) Chart vital signs: temperature, pulse, respiration and blood pressure are recorded every two hours for the first eight hours. Capillary circulation is judged by the color and temperature of the skin.

Sedation. Rest lowers the oxygen requirements of the tissues. The extent and depth will determine the dosage. Demerol® is preferable to morphine, as the latter may depress the respiratory center which is already depressed by the severe peripheral vascular deficiency. The narcotic may be given intravenously, since there is delayed abosrption. One gram of procaine in the infusion may result in some local anesthesia over the burn area. Amytal® and phenobarbital may be administered intravenously.

Oxygen Therapy. This lessens hypoxia and increases the oxygen supply to the tissues. Intranasal catheter administration of oxygen is preferable to the oxygen tent, as the latter may result in overheating. Oxygen therapy should be available for respiratory burns and burns in the aged.

Replacement Therapy. Each burn patient must be closely observed and the therapy adjusted accordingly. Patients with extensive burns require large amounts of water, electrolytes and colloids to compensate for the acute internal dehydration. Wallace[21] has shown that adults do not require intravenous fluids when less than 18 per cent of the body surface is burned. Children require intravenous therapy when 12 per cent of the body surface is burned.

Colloids: Colloids are administered to maintain the osmotic pressure and are indicated when the hemoglobin rises above 19 gm. The replacement of the plasma protein reverses the pathologic shift of fluids and electrolytes, reestablishes the blood volume, relieves the excessive arteriolar constriction, reduces the hemoconcentration, and prevents capillary stasis and tissue anoxia.

Quinby and Cope[22] studied the blood viscosity and its relationship to whole blood therapy of burns. Their studies indicate that while whole blood augments the high hematocrit, and therefore increases the viscosity, no ill effects could be demonstrated. The effects of abnormal viscosity in experimental dogs showed no remarkable effects on the pulse, blood pressure and kidney function.

Harkins advocated 1,000 cc. of colloid for each 10 per cent of body surface involved, or 100 cc. of colloid for each point the hematocrit rose above 45.

Evans believed that whole blood was the bulwark in the planning of intravenous therapy in the treatment of shock in the extensively burned patient. Whole blood restores the circulating red blood cell volume as well as the plasma volume. Whole blood is superior to plasma for peripheral circulatory failure, provided a buffered saline solution is administered at the same time. Gelin[23] does not administer whole blood in the acute stage unless anemia is present. Hemoconcentration is regarded as a contraindication to the administration of whole blood.

Colebrook[24] does not utilize whole blood, as he believes it adds more red cells when hemoconcentration is present. Blood transfusion is used for the late anemia, and to compensate for loss of blood during the skin grafting stage.

Electrophoretic measurements show that whole blood transfusion does not correct the abnormal blood picture.[25] Evidence suggests that in addition to whole blood, transfusion with purified normal human serum albumin or a blood substitute suitable for albumin replacement is essential.

Plasma substitutes maintain blood volume, but not a sufficiently high level of plasma protein, so that whole blood supplementation is necessary.

Dextran (macrodex) is effective in expanding the plasma volume and is available in unlimited quantities.

Gelatin (P. 20, P. 90, oxypolygelatin) and dextran solutions are as effective as pooled plasma.[26] Lightly degraded gelatin solution is retained longer in the blood stream and appears to be as effective and safe as plasma.[27]

Polyvinyl pyrrolidone (periston) plasma expander shows no evidence of toxicity or organic dysfunction.[26,28]

Globin is prepared from unwashed red cell residues and can be used as a substitute for plasma in intravenous therapy. In a 4 per cent concentration, globin has the same colloidal osmotic pressure as a 7 per cent plasma protein solution.

The administration of pure human serum albumin to replace the lost albumin will prevent or correct hemoconcentration.[25]

Electrolytes: The rationale of fluid and electrolyte therapy is based on the knowledge of the pathologic physiology of burns. Electrolytes are given to secure and maintain a minimal urinary output of 50 cc. per hour. The electrolyte solution is of the extracellular type, (sodium, chloride and carbonate). Potassium and phosphate may be added. Large quantities of salt are given due to the rapid fall of serum sodium. During the acute stage, sodium and chloride are the chief ions lost. Laboratory and clinical evidence shows that saline therapy alone will not sustain the circulation in acute burns without causing generalized tissue edema.

The hourly urinary output is usually a guide to proper fluid and salt therapy. The urinary output as an index to burn shock may not be accurate. When the blood pressure falls, renal filtration as well as the urinary output falls. Excess potassium administration is to be avoided if the urinary output is deficient. The serum potassium level can be lowered by administration of large amounts of glucose with insulin.

If anuria is suspected from slow rate of urinary excretion, the so-called "water test" may prove valuable in attempting to determine whether the slow rate of urinary excretion is due to renal failure or to inadequate treatment. This consists of the rapid administration intravenously of 1,000 cc. of distilled water with 5 per cent glucose; if the rate rises precipitously during this period, the therapy can be considered inadequate and its rate should be sharply increased. If there is little if any response, the rate of fluid administration should be sharply curtailed, for continuation of therapy may lead to a disastrous overloading of the extracellular compartment and pulmonary edema.[29]

An estimation of the adequacy of sodium administration may be judged by determination of the urinary sodium chloride. If this amounts to 3 gm./L. of urine, treatment may be considered adequate.

Water: Water is lost through evaporation from the respiratory epithelium, skin and from the urinary output. If one assumes 1,000 cc. per day for insensible loss, it is apparent that the total baseline water intake must be between 1,800 and 2,500 cc. to prevent dehydration and to insure water balance. Signs of dehydration are present when there is a loss of an amount of body water equal to 6 per cent of the body weight.

Water and electrolytes are given to restore the extracellular fluid which has been shifted from the non-injured to the injured tissues.[8] Administration of 100 gm. of glucose diminishes the amount of nitrogen lost in the starving patient by 50 per cent. Therefore, 100 gm. of glucose is an essential part of the baseline requirement for each patient.

Intravenous therapy: Evans[30] utilized 75 cc. of colloid and electrolyte solution for each percentage of surface involvement. Cope and Moore stated that such surface formulas disregarded differences in the weight of patients. Evans recognized the dangers of overhydration in the use of a surface area formula in estimating fluid and salt requirements, especially in severe burns. Brooks found that in burned dogs there was a loss of 1 cc. of plasma for each percentage of body surface per kilogram weight. An analysis of plasma volume data in a series of burn patients indicated that approximately the same ratio of plasma deficit existed in human burns involving 20 per cent of the body surface. Therefore, the following formula was evolved by Evans for estimation of colloid, salt and water requirements: (1) Colloid (plasma substitute or blood): 1 cc./kg. × per cent of body surface. (2) Electrolytes: 1 cc./kg. × per cent of body surface. Isotonic saline or one of the electrolyte solutions is administered. Ringer's lactate solution or molar sodium lactate is given to prevent acidoses. Coller advocates normal saline at half-strength and buffered with

sodium lactate to restore the extracellular fluid and electrolytes in the presence of impaired renal function. (3) 5 per cent glucose in water, 2,000 cc. per day.

The total twenty-four-hour intake should not exceed 10 per cent of the body weight. One-half the dose is given in the first eight hours. Half of the colloid and electrolytes are given the second day. The 2,000 cc. of glucose in water is maintained. Burns involving 25 per cent or more of the body surface require equal quantities of whole blood and plasma. Burns covering more than 50 per cent of the body are considered 50 per cent. There is a definite limit above which the extracellular space cannot be expanded safely. The amounts are modified by the patients' response, as indicated by the thirst, pulse, blood pressure and urinary output.

Overhydration may be caused by overestimation of the burn area. Children, the aged, cardiac patients and patients with respiratory burns require less than the estimated volume of fluid.

Intravenous therapy is discontinued when the output exceeds the intake and oral feedings are well tolerated.

Oral therapy: Oral intake should be restricted in the first twenty-four hours. Half normal saline by mouth may be indicated in elderly patients with pulmonary burns. Buffered saline solution may be given after shock has ceased.

Acidosis develops in some patients when they are treated solely with a sodium chloride solution. Therefore, Moyer's solution (4 gm. NaCl and 2 gm. Na HCo_3)[31] or Haldane solution (3½ gm. NaCl and 1½ gm. $NaHCo_3$) is given orally. These mixtures are close to the physiologic ratio in the extracellular fluid where the proportion of sodium to chloride is nearly 3:2.

Salts are added to drinking water to prevent dilution of body fluids and water intoxication. Saline by mouth results in nausea, vomiting, cramps, diarrhea and tends to produce acidosis.

A patient with a falling sodium concentration does not excrete water. It is retained and a large portion enters the cells and causes swelling. This results in headaches, nausea, vomiting, disorientation, watery diarrhea, salivation and lacrimation. The water is not excreted in the urine and remains in the body to dilute body salts. Renal function is impaired by the decrease in the concentration of the salts in the extracellular fluid.

Infection and Antibiotics. All burn wounds are contaminated. The invasion of the burn area by virulent bacteria in the first twenty-four to forty-eight hours results in primary infections. Infection in the devitalized tissues sets free toxic substances with resultant toxemia. Infection in the slough may result in cellulitis.

Secondary contamination after the seventh or eighth day is due to secondary invasion by streptococcus or staphylococcus.[8] Antifibrinolytic properties occur in the blood of patients with acute hemolytic streptococcus infection.[32] Group A streptococcus sometimes produces an extracellular proteolytic enzyme in broth culture.[33] The incidence of infection increases in direct proportion to the depth of tissue destruction.

Penicillin, 300,000 to 1,000,000 units, is given in order to obtain a high penicillin level in the circulating blood, cellular fluids and the burn exudate. Clinical response to the infection will determine the increase in penicillin dosage or a change of antibiotic.

Cultures from beneath the crust and sensitivity tests will determine the antibiotic of choice. The organisms develop resistance while exposed to the antibiotics so that frequent changes are necessary. It is desirable to administer a combination of antibiotics.

In spite of the antibiotics, and survival of the shock stage, the patient may die from sepsis after several weeks.

The flora of burns may change with progress of the burn. Proteus and pyocyaneus organisms may complicate the picture. Burns of the legs and buttocks require streptomycin therapy for coliform bacterial contamination. Polymixin B appears specific for strains of Pseudomonas aeruginosa.[34]

The suggested dosages for the antibiotics are as follows: terramycin® and aureomycin, 10 to 20 mg. per pound of body weight per twenty-four hours; erythromycin, 15 mg. per pound of body weight every twenty-four hours; streptomycin and dihydrostreptomycin, 10 mg. per pound of body weight per twenty-four hours; polymixin B, 1.1 mg. per pound of body weight per twenty-four hours. Sulfonamides may be used if renal function is adequate.[20]

The local use of antibiotics, sulfa-film dressings or local application of bacteriostatic agents are less effective in controlling infection

in burns than the parenteral injection of these drugs.[35]

Colebrook[24] believes that strict asepsis, combined with topical penicillin, will reduce infection.

The available evidence shows that if a toxic substance is formed at the site of a burn, it may be carried in the blood stream to other parts of the body. The problem of non-bacterial toxemia of burns has not been settled.

Recent observers[36] believe that septicemia, rather than toxemia, is the principle cause of death, and they recommend a vigorous regimen of early excision of eschar and skin coverage. They have isolated microorganisms from the blood stream, and their evidence indicates that toxins associated with burns are not products of tissue degeneration but are bacterial tissues. Thus, toxemia may be a manifestation of septicemia.

Hormones. A burn causes a stress response with release of an adrenal hormone, presumably Compound F.[37] The degree of the reaction is determined by the eosinophil depression and by the daily urinary excretion of corticoids (5 to 8 mg.) and total neutral 17-ketosteroids (7 to 20 mg.). The early metabolic alterations, sodium retention, excretion of potassium and nitrogen, and eosinopenia are indicative of adrenal cortical activity.

A prompt drop in the circulating eosinophils is to be expected immediately after a burn and indicates that the adrenal mechanism is intact. It is the subsequent rise or failure to rise which may have prognostic significance.

Failure of the eosinophils to reappear by the third day following a burn is a grave prognostic sign.[38] A prolonged severe depression of the total eosinophil count following the initial burn indicates a poor prognosis.[39] A flood tide of eosinophils, counts ranging from 400 to 2,000, is to be expected during the later weeks or months in extensively burned patients making satisfactory progress.

A secondary fall in eosinophils is to be expected after burn dressings and skin grafting.

Wilson found the excretion of corticoids to be sharply elevated and this excretion remained at an elevated or a normal level throughout the course of the burn. The excretion of 17-ketosteroids was frequently elevated initially but declined in the severe chronic burn, in contrast to the excretion of corticoids.

The administration of steroids may result in excessive fluid retention and development of pseudodiabetes.

Evans[10] and his co-workers believe that the administration of ACTH is unnecessary as the burn itself is a maximum stimulus to the adrenal cortex and the patient liberates enough ACTH of his own.

Cortisone and ACTH may be of value in lethal burns and in the shock stage in children.[20] The dosage is as follows: children, age four: 40 mg. of ACTH, 50 mg. of cortisone; children, age ten: 60 mg. of ACTH, 125 mg. of cortisone; adults: 80 mg. of ACTH, 200 mg. of cortisone.

The hormones may suppress the signs and symptoms of intercurrent infection and should not be used in the stage of anemia and hypoproteinemia. ACTH eliminates the local cellular response which is the first line of defense. Cortisone should not be given after the fifth day because of the hazards of decreased resistance to infection.

The experimental work of Cope[40] indicates that adrenal cortical extract and posterior pituitary extract probably have no value in decreasing capillary permeability nor in favorably altering the metabolism in burn shock.

Positioning of Patient. Posture influences the blood flow and resultant occurrence of edema.

Elevation of the head is indicated in patients with burns about the face. Elevation of the extremities may prevent edema. Abduction of the upper extremities will prevent contractures about the axilla.

Prolonged bed stay may require foot boards to prevent foot drop. The Stryker frame is of extraordinary value in the management of patients with extensive burns by facilitating gentle handling and turning of the patient.[19]

In children, burns of the buttocks may be treated in Bryant's traction.

In adults, burns of the buttocks may be treated with the patient in the prone position, with the feet hanging over the edge of the mattress.

Active and passive motion of all joints should be maintained.[41]

Laboratory Tests. The urine is examined for the presence of red blood cells, breakdown products and specific gravity. Carefully spaced blood studies are obtained such as hematocrit, hemoglobin, red blood cells, sodium, potassium, carbon dioxide combining power, chloride, plasma protein and circulating blood volume.

Plasma protein, sodium, potassium and chloride fall after the first few days, whereas calcium and magnesium remain unchanged.[2] There is a decrease in the serum sodium, whereas the chloride loss is not large or significant. There is a shift of some sodium into the injured cells with a concomitant shift of an equivalent amount of potassium.

Blood urea nitrogen and non-protein nitrogen studies determine the amount of protein breakdown and renal function. Liver battery tests will determine the degree of liver damage.

Following the acute phase, the aforementioned tests are repeated as often as necessary, guided by the clinical picture. The loss of hemoglobin, protein and potassium during the late stage requires repeated study.

The therapy is guided by these various determinations and by the clinical appraisal of the patient.

Stage of Diuresis. The edema of the burn reaches its peak in forty-eight hours and a reversal takes place. The space of burn edema begins to absorb between the third and fifth days, and the electrolytes and proteins are returned to the intravascular space. A portion of the electrolytes lost into the edema fluid is reabsorbed into the circulation as the burn edema resolves. The extracellular space is expanded and may produce pulmonary edema unless the hydration therapy is reversed. There is a rise in the urinary output, and a rapid loss of weight with disappearance of nausea and distention.

The cardiovascular system has begun to pick up the heretofore unavailable extracellular fluid in the region of the burn area. Edema fluid is resorbed into the blood stream by the lymphatics and may lead to hemodilution and anemia. This calls for a drastic reduction in infusion rate and a shift to an oral intake to replace the insensible loss.

Indication that such fluid is being mobilized may be derived early from an increase in the rate of urinary excretion. If urinary excretion rises above 200 cc. per hour, all water and electrolyte should be stopped or continued only at a rate sufficient to produce a rate of primary excretion from 100 to 150 cc. per hour.

After the first forty-eight hours, more than 2 to 4 gm. of sodium chloride is rarely given because of the profound adrenal cortical response preventing renal excretion of sodium.

As diuresis occurs, sodium is mobilized; and following the rapid excretion of potassium through the kidneys, the patient may suffer from potassium deficiency.

Stage of Nitrogen and Hemoglobin Loss. It is well established that significant nitrogen depletion occurs in patients with severe burns. Positive nitrogen balance is maintained for the first seventy-two to ninety-six hours due to plasma and blood administration. This is followed by a negative nitrogen balance commensurate with the severity of the burn. The nitrogen balance may remain negative in spite of high caloric intake, and the maintenance of adequate nutrition may be a problem. Burns involving 30 to 40 per cent of the body surface are frequently followed by nitrogen excretion ranging up to 45 gm. per day. The amount of nitrogen lost in the burn exudate may become more marked unless the wound is closed by skin grafting.

There is a progressive protein, red blood cell and hemoglobin loss in burns involving more than 10 per cent of the body surface.

There is extensive destruction of tissues in large burn areas, and a continuous loss of nitrogenous products from the burn surface and an increase in urinary excretion of non-protein nitrogen beginning three or four days after a burn and reaching a peak during the first and second week and persisting for three or four weeks.

Intensive feeding is necessary to meet the increased needs for tissue regeneration, red cell regeneration, liver protection and accelerated metabolism.

Administration of 1,000 calories in excess of the normal daily requirement is necessary to maintain nutrition. Protein, 150 to 600 gm. per day, may be necessary to retain the patient's nitrogen balance. The average adult can tolerate up to 4 gm. of supplementary protein per kilo per day. Children can tolerate up to 3 gm. per kilo. Food supplied must be a complete metabolic mixture containing adequate protein, carbohydrate, fats, minerals, water and accessory food substances.

If possible, the nutritional demands should be met by oral feedings. If this is not possible, gastric, jejunal and parenteral feedings, single or in combination, must be administered.

Fat and carbohydrate are necessary to spare protein. Adequate carbohydrate will help prevent ketosis and protect the liver.

Forced feedings are given through a small flexible polvethylene tube, administered by a

gravity apparatus as a constant intragastric drip. Tube feedings are not well tolerated before the third day.

Blocker has devised a pump which delivers a whole mixture containing milk, eggs, dextrose and protolysate® from a vacuum bottle reservoir at a constant rate of speed without danger of clogging the tube. Forced feedings are continued until the patient is able to take sufficient food orally to maintain his nitrogen requirements.

Ready-made preparations are available as protein concentrates, amino acids, somagen® and lipomul.® Ascorbic acid, 1 gm., is given daily as well as other vitamin supplementation.

Following the shock and diuresis stages, there is a rapid development of a protracted and resistant anemia, which is the result of increased destruction and disturbance of hemoglobin production.

There is a deficiency of the protein hemoglobin (ion and globin) and a disturbance of hemoglobin both in the pigment and protein fractions. Hemoglobinuria may be present for the first twelve hours. The hemoglobin protein free in the plasma in excess of 40 mg. is excreted in the urine.

Heat causes increased fragility and destruction through stagnation in the liver and spleen with sludging of the blood. Red cells are stagnated and trapped in the larger sloughing areas and are thereby destroyed.

Even though the patient may come into positive nitrogen balance, anemia may persist due to the deficiency in hemoglobin production.

Repeated transfusions are given at the time of débridement of the burn slough, and to compensate for the continued loss of red blood cells in the dressings. Severe bleeding may result from the burn slough due to poor liver function and low prothrombin concentration. There is a loss of sodium, potassium, calcium and protein from the large raw surfaces and granulations, which must be compensated by an increased oral intake or parenteral feeding.

COMPLICATIONS

Pseudodiabetes may develop as a result of the stress response[37] plus the forced feedings of a high carbohydrate diet. The glucocorticoids act on carbohydrate metabolism and gluconeogenesis is enhanced. The treatment consists of reduction of the caloric intake and adjustment of the proper ratio of fats, protein and carbohydrates.

Gastric dilatation may be caused by peripheral circulatory collapse causing abdominal distention. Overloading with oral fluids or food may result in gastric dilatation or hemorrhagic gastritis.[2] Gastric distention, vomiting and peripheral circulatory collapse require the administration of prostigmin® supplemented by the Levin tube.

Mania may develop due to extensive central nervous system involvement with gradual deterioration into a comatose state. The patient may die in three or four weeks of hyperpyrexia without any evidence of blood stream or local infection, despite normal water balance and blood chemistry.[11]

Thrombosis: Thrombophlebitis occurs in about 13 per cent of burns. Heparin prevents thrombosis in areas of sludge formation, reduces blood viscosity, improves lymphatic drainage from the burned area and diminishes the clotting of lymph.[2] Heparin does not prevent sludging, but prevents thrombosis. The edema subsides after forty-eight hours if there is no lymphatic or venous obstruction. Heparin, 200 mg., is given in 1 L. of saline at the rate of 25 drops per minute to maintain the coagulation time at about thirty minutes. The coagulation time is checked every four hours.

Fractures associated with burns: On the experimental work in dogs, rigid immobilization is essential to avoid a spreading infection.[42] Bone infection did not occur when the bones were rigidly fixed by intramedullary nail and the burn left open, but did occur in some cases when plaster casts were utilized. The introduction of an intramedullary nail through the burned skin did not increase the bone infection.

Liver insufficiency: Jaundice may be present during fulminating toxemia as early as forty-eight hours, but more pronounced jaundice occurs in the slow progressive low grade toxemia about the fourth day.[43] Hepatic damage may be present especially from the third to tenth days following the burn. Jaundice is indicative of degenerative and necrotic changes in the liver.

Evidence of liver damage in severe burns may be determined by the standard liver function tests (increased bromsulphalein retention, increased serum bilirubin concentration, increased urine urobilinogen excretion, increased prothrombin time and abnormal cephalin floc-

culation). Disturbance of liver function will occur particularly if shock is severe.

Liver lesions and acute toxemia are produced by the same mechanism. A high carbohydrate and protein diet lessens the toxic changes.

Renal insufficiency: The work of Mallory and Lucke demonstrated that acute renal insufficiency is due to a lower nephron nephrosis. The predisposing factors are a shock-like state and hemolysis with mobilization and excretion of either hemoglobin, myoglobin or oxyhemoglobin in the urine.

The pathologic examination reveals normal glomeruli while tubules reveal varying degrees of necrosis followed by the appearance of pigment casts in the distal tubules.

Intravascular hemolysis is a factor in the pathogenesis of renal injury due to the direct action of heat on the red cells. The products of hemolysis are toxic to the kidneys.[44]

The pathology is similar in shock, mismatched blood transfusion, sensitivity to sulfonamides and crush syndrome.

Haynes[45] studied the renal function in severely burned patients and found the characteristic response to a burn included an increased glomerular filtration rate, a normal effective renal plasma flow and an increased filtration fraction. The tubular function on the other hand appeared normal. These values trend downward to reach a normal level about two and a half weeks following the burn.

Altschule has demonstrated that hemoglobin is excreted in the urine only when the level of free hemoglobin in the plasma reach values of about 150 mg./100 cc. of plasma. Below this concentration, it is apparently completely reabsorbed from the glomerular filtrate by the renal tubules.

Complications of shock with diminished blood flow interferes with the regulation of electrolytes and may result in renal failure.

Oliguria during shock is due to a markedly decreased blood flow through the kidney. Anuria will ensue if the renal ischemia persists. Disturbances in renal function are more severe and protracted when the shock is profound and lasting. Severe reduction in the renal blood flow as a result of circulatory failure results in impaired kidney function and pathologic changes in the kidney. Adequate filling of the circulatory system prevents the kidney arterioles from remaining in a state of spasm.

Renal function is markedly diminished to the point of temporary anuria which can become permanent unless adequate replacement of the circulatory volume is effected.

Impairment of kidney function is evidenced by persistent azotemia, oliguria and diminished nitrogen excretion. This may be accompanied by albuminuria and the presence of urinary casts.

Azotemia may be due to the increased production of non-protein nitrogen in the presence of the failing kidney. A moderate to marked increase in the blood non-protein nitrogen is common in burns due to the addition of nitrogenous bodies as a result of destruction and absorption of the burned tissues. The daily blood chemistry determination serves as a valuable index in the prognosis.

Shock must be treated, dehydration controlled and the patient's optimum salt and water balance maintained. A normal output of a concentrated specific gravity is indicative of good renal function.

The early replacement of blood, plasma and extracellular fluid defects constitutes the most effective method of prevention of anuria. If the circulatory failure is relieved, the kidneys will be able to rid themselves of circulating hemoglobin from the damaged red cells.

Deficiency of serum sodium is contributory to circulatory collapse and results in suppression of urine formation. Care must be taken in the administration of fluids, particularly sodium-containing fluids, to avoid overloading the circulation.

The rapid lethal accumulation of potassium as a result of massive protein breakdown may be deleterious and require the use of an artificial kidney, if irreversible anuria occurs early in the course of a severe burn. Dialysis by the artificial kidney provides a means of delivery of the excess fluid and removal of the excessive potassium.

The presence of oliguria and the administration of potassium-loaded plasma may be a contributory factor leading to hyperpotassemia.[46] The latter is rarely present in the absence of oliguria.

When anuria occurs without any response to the increase in the rate of parenteral therapy, one must suddenly reverse fluid therapy and restrict the intake just to that of insensible loss plus burn loss. The intake is restricted to 1,000 cc. of 10 per cent glucose per day until renal function returns.

LOCAL TREATMENT

The primary aim is to avoid contamination and infection, provide and promote drainage, minimize the lymphatic drainage, obtain a dry sterile wound and secure healing in the optimum time with minimal loss of function.

Local and systemic treatment should be carried out simultaneously since the local lesion is responsible for the systemic reaction.

Definitive treatment of the burn is started following the institution of shock therapy. The burn area is gently cleaned with phisoderm® or some other detergent. Copious irrigations with warm saline are used to wash off the dirt and detritus. Blebs are not necessarily incised or excised because of the danger of opening avenues of infection. The blebs may be punctured and allowed to collapse. Scrubbing or forceful cleansing is avoided.

Local drugs have little effect upon the healing of a burn and often prove detrimental.[47] When drying of the wound has been achieved and infection controlled, the treatment of a full-thickness burn becomes a surgical problem of skin replacement.

Local treatment of burns has gone through many phases: wax, tannic acid, pressure dressings and the exposure method.

Closed Method (*Pressure Dressings*). Allen and Koch introduced the occlusive pressure dressing in 1941 and this has been used successfully up to the present time. The objective is to cover the open wound with the simplest possible dressing that will protect it from reinfection, provide for drainage of serum, exert a uniform moderate pressure, and be easily removed if infection develops.[48]

The aim is to create a dry wound free from infection and receptive to early skin grafting. Evans found the separation of burn slough occurred sooner when the closed method was used.

The early application of pressure dressings to counteract edema fluid collection will avoid loss of the capillary filtrate. The dressing should not impair the venous return.

The occlusive dressing is ideal for encircling burns of the extremities. Pressure dressings about the thorax and abdomen are uncomfortable and may slide and convert a partial burn into a full-thickness burn. Burns of the fingers should be dressed individually with gauze pads placed between each digit and the hand maintained in the optimum position of function.

Infrequent dressing of burn wounds under strict asepsis will help prevent infection.[49] The dressing is removed in twelve to fourteen days unless there is gross soiling or infection. Care must be taken in the removal of the thin gauze layer next to the healing area so as not to traumatize and disturb the healing process. The dressing is changed when sepsis appears with oozing of fluids through the dressing or by an increase in the local tenderness. A fine mesh gauze over an infected or macerated area will prevent drainage and result in a temperature rise.

Many modifications of the closed method have been advocated: (1) Dry fine mesh gauze, vaseline gauze or furacin® gauze may be used as a compression dressing. (2) Evans devised a one-piece dry burn dressing to insure a dry wound by the absorption of the burn exudate. (3) A one-piece dressing is used at Brooke Army Hospital. (4) Curry devised a pneumatic apparatus using compressed air between layers of rubber or supporting material to apply pressure to the lower extremities.[50] (5) Spangler[51] advocates the application of a gel compound of partially hydrolized casein, sodium lactate, and sodium lauryl sulfate covered by a coarse mesh gauze impregnated with zinc acetate. The gel covers the burn with an adherent, impervious protective membrane (zinax®). Healing is faster, loss of serum less, scarring minimal, incidence of infection reduced and pain ameliorated more rapidly. (6) Lehman[52] has suggested the use of a controlled pressure dressing of polyvinyl plastic sheath for the extremities. It is a sheath within a sheath to exact uniform pressure on the extremity. This pneumatic plastic pressure sheath is transparent and permits constant observation of the wound. (7) Douglas[53] reported a pressure jacket for the treatment of wounds. (8) Choy[54] advocates the use of polyvinyl chloride acetate copolymer in ethyl acetate solvent as a plastic spray dressing for burns. (9) Bunyan[55] used an envelope for the irrigation of burns and wounds during World War II. (10) Curtis[56] advocates the use of a partially hydrolyzed casein gel which is applied to the burned area and covered with gauze impregnated with zinc acetate. This semipermeable membrane prevents the protein loss, and by support given the damaged capillary bed, diminishes the

protein loss into the burned area, thus minimizing local cellular damage and shock. (11) Levenson and Lund utilized pressure bandages and thick close-fitting plaster casts.

Open Method (Exposure). Wallace,[21,57] in 1949, reintroduced the exposure treatment of burns. The burned area is cleansed, dried and dusted with powdered penicillin lactose, supplemented with parenteral penicillin therapy.

The objective of this method is to obtain and maintain a dry surface, which will be unfavorable to bacterial growth.

A high relative humidity and a low environmental temperature are limiting factors for the successful use of the exposure method. The latter gives rise to early and mild fever, whereas the occlusive dressing results in prolonged hyperpyrexia.

Advocates[58] of the exposure method believe that drying of the burn occurs more rapidly and therefore lessens the possibility of infection. Time-consuming and expensive dressings are avoided, and mass casualties can be treated with limited personnel.

Blocker[59] states the conversion of the burned tissue into a dry slough to form a mechanical barrier against invasion by pathogenic organisms which require warmth and moisture. Fewer patients require grafting, healing is faster, blood and protein requirements are less, and the period of hospitalization is shortened.

The exposure method is useful in burns of the face and perineum. Artz[60] believes the exposure method depends on the development of hard crusts formed chiefly from the exudate of partial-thickness burns and on the integrity of the dry eschar composed of the dead skin of deep burns.

Patients with circumferential burns of the chest, abdomen and buttocks can best be treated on a Stryker frame, being turned every few hours until a hard eschar is formed.

The burn surface oozes serum which coagulates. The surface becomes sticky, then converts gradually to a brownish crust which becomes darker and tougher in time.

Formation of this coagulum is hastened by immobilization, elevation and avoidance of the abrasive action of dressings and linens. The coagulum forms a latticework for epithelium to bridge the denuded area.[61]

McDowell[62] mentions the disadvantages of bed confinement and special traction apparatus which are necessary, because repeated motion on flexor surfaces will cause breaking of the eschar within two to three days and prolonged or recurrent contact with bed clothing and supporting apparatus will result in frank disintegration of the eschar. Whenever the eschar is broken, surface infection, exudation, formation of exposed granulation tissue and further loss of eschar may ensue.

A collection of pus underneath a burn eschar does not occur spontaneously but is produced by undermining from moist areas at the edge or where a crack from motion occurs.

Full-thickness burns eventually become infected and remain infected until the burn slough is removed and the area grafted. Full-thickness burn crusts form in about seventy-two hours.

Most eschar is excised in ten to fourteen days, following which moderate compression over an absorptive dressing is used both before and after grafting.[60]

Pemrick[18] lists the following advantages of the open method: (1) increases attention to the wound, (2) lessens pulmonary complications, (3) allows dissipation of head, (4) encourages mobilization, (5) eliminates warm moist environment for bacterial growth, (6) reduces invasive infection, (7) permits earlier wound closures, (8) simplifies care and saves material, (9) eliminates uncomfortable fetid dressings and (10) eliminates use of anesthetics and laborious changing of dressings.

Spontaneous epithelization: Extensive full-thickness burns will result in contractures, distortion and loss of function unless the lost skin is replaced. It is the patient's natural ability to heal rather than the local therapy which is responsible for spontaneous epithelial regeneration.

There may be a rapid growth of epithelium from the edges of the wound which results in an excessive scar type of epithelium which breaks down, ulcerates and forms contractures.[63]

Fibrosis and contractures are avoided by elimination of infection, physiologic positioning, early débridement and skin grafting. Burns overlying joints will result in ankylosis unless adequately covered by skin.

Débriding agents: The phase between shock therapy and skin grafting is often prolonged and no standard method of hastening the healing of burns has been found. The ideal agent has not been found, although various

agents have been used to débride burns. An intensive search has been made for chemicals which will remove dead skin without injury to the normal tissues.

The necrotic slough invites infection and therefore must be removed before the graft can be applied. Surgical or chemical débridement hastens elimination of the source of infection by removal of the slough and necrotic tissue.

The delineation of normal from burned skin may require a long period of time. Separation of the burn eschar by spontaneous sloughing requires three to five weeks. This time may be shortened by enzymes to digest the material which comprises the coagulum.

Gradual débridement: The use of moist saline dressings or whirlpool baths will permit gradual removal of the slough and eschar as it becomes loosened.

Infected wounds are dressed by applying a layer of fine mesh gauze next to the slough, covered by a layer of sterile compresses, mechanic's waste and elastic bandage. Catheters are incorporated for moistening of the dressings with normal saline.[48]

Brown uses 3 per cent xeroform® in vaseline which will not macerate the skin. Wet dressings of aqueous zephiran® (1:1000) and 1 per cent acetic acid are used to combat pyocyaneous infection, and as a dressing prior to skin grafting.

Acid débridement is dependent on prolonged lowering of the pH of the wound surface. A plane of cleavage begins at the wound margin and proceeds to the deeper planes. Separation of non-viable tissue occurs without injury to the epidermal islands.

Acid débridement[65] has been utilized in small burns which do not require ultimate skin grafting. An inflammatory base of granulation tissue is obtained which is not optimal for grafting. Phosphoric acid and pyruvic acid preparations are usually painful.

Pyruvic acid[66] has been used as a rapid agent for separation of the necrotic slough of full-thickness burns by the application of a 1 per cent pyruvic acid starch paste.

Phosphoric acid gel[67] has been suggested as a simple, safe, selective and rapid method of débridement.

Tryptar®[68] is a crystalline trypsin used to débride grossly infected granulating wounds. The optimal pH range of tryptic activity is 6.8 to 7.5. Wilde[69] advocates using tryptar as a débriding agent in fresh burns. Tryptar is applied as a dust of the dry crystalline enzyme to the exposed area.

Streptococcal enzymes[70] are antigens and are effective not by liquefying the burn slough but by liquefying the fibrin and gelatinous material which permits the slough to separate. Streptokinase and streptodornase are applied when the slough is not separated from the viable tissue. The burn eschar is attached to the underlying viable tissue by thick collagen bands, and streptokinase and streptodornase cause only the hydrolysis of desoxyribose nucleoprotein and desoxyribose nucleic acid and the liquefaction of fibrin, respectively. Streptococcal enzymes are active as proteolytic agents only on fibrous and cellular coagulum, whereas the burn eschar is attached to the underlying viable tissue by a thick band of collagen.[71] Streptokinase and streptodornase are valuable in cleaning up infected burns although allergic reaction has been reported. These two enzymes may be incorporated in lubafax® and placed over the wound for lysing susceptible portions of wound exudate and sloughs.

Papain,[72] a fibrinolytic enzyme, is suggested as an effective method of débridement in the treatment of chronic suppurative and necrotic areas. This is applied as a powder or a dressing soaked with the solution of the enzyme papain (the dried milky juice of the melon tree, carioca papaya).

Clostridium histolyticum proteinase has been used experimentally in burns, creating liquefaction and separation of the eschar within forty-eight hours.[73] Further experimentation is necessary to determine any toxicity that may be associated with the digestion of the slough and absorption of split protein products.

Skin grafts: Early restitution of the body surface by grafting will prevent the loss of protein, electrolytes and fluids, prevent infections and avoid deformities. Early skin grafting will reduce debilitation from chronic open burn wounds. The necessity for skin grafting can usually be determined at the time of the burn, the ideal time being between the twelfth and eighteenth day. Skin grafting should not be attempted on an infected granulating wound. Ointments are a poor substitute for skin grafting.

Very thin split-skin grafts may be used in order to reuse the site in about ten days. A wet

or dry compression dressing is utilized following the application of the grafts.

Excision and skin grafting: Early excision and grafting shortens the period of protein loss, lessens infection and toxic absorption, and minimizes scar formation. Primary excision and grafting may be prevented by the general condition of the patient.

An electrical burn may be excised and grafted as a primary procedure.

Cope[64] advocates removal of the original dressings in ten to fourteen days, followed by excision of the slough and application of skin grafts. This procedure may be impractical due to the difficulty in judging the depth of the burn, the problem of excessive bleeding and difficulty in obtaining hemostasis of the graft bed.

Allen[47,63] favors excision and delayed grafting. Débridement is performed on the eleventh day followed by the application of pressure dressings. Skin grafts are applied about fourteen to sixteen days after the occurrence of the burn.

Jackson[16] considers healing time from the time of injury to complete epithelization and separation of all scabs. Of 1,578 burns, the mean healing time for partial skin loss was twenty days; for complete skin loss, fifty-one days; and for extensive burns requiring shock treatment, seventy-two days. The mean healing time for full-thickness burns involving less than a 2 per cent surface area, with primary excision and grafting, was thirty-four days and without primary excision and grafting, forty-six days.

Homografts: The use of homografts may be a life-saving procedure until the patient recovers sufficiently to permit the use of autografts. Homografts adhere to the bed of granulation tissue, seal the loss of protein and electrolytes, and afford a viable body covering. These grafts may remain in place from three weeks to four months and finally melt away by a process similar to liquefaction necroses. The protein in the homograft acts as an antigen and the destruction is the result of an allergic response. There is stimulation of epithelization and complete healing will occur even after absorption of the homograft.

May[74] states that ACTH is used to block or at least lower the antigen-antibody response of the skin and make homograft skin transplantation permanently possible.

Many observers[75,76] believe that ACTH is of no value in prolonging the life of the homografts.

Brown[13] believes that homografts will take and grow with or without hormones and independent of blood groupings, but persistent survival in consistent use has yet to be proved. The advantages of postmortem homografts as biologic dressings for extensive burns and denuded areas is stressed.[77] Such grafts may be used immediately or stored for several days either folded or wrapped in saline gauze and kept at about 4°C. or in 10 per cent serum.

CONCLUSIONS

Burns pass through three clinical stages: (1) Shock: Great strides have been made in the treatment of shock due to the better understanding of the physicochemical changes in salt and water balance. Death may occur from the diminished blood volume and its concomitant sequelae. (2) Toxemia: Sepsis may be prolonged and extend well into the healing stage. Toxemia and septicemia present unsolved problems which have yet to be conquered. Death may result from infection, in spite of the use of antibiotics. (3) Healing: Closure of the skin occurs by separation of the slough, granulation and epithelization. Death may occur from sepsis and debilitation.

Systemic treatment is directed to the correction of the disturbed physiology. This is accomplished by restoration of blood volume and extracellular fluids to compensate for the acute internal dehydration; reversal of hydration therapy by withholding of electrolytes and fluids during the stage of diuresis; and replacement of sodium, potassium, protein and red blood cells to compensate for losses from granulating surfaces during the stage of healing.

Local treatment is directed to the healing and closure of the burn wound. This is accomplished by use of a local therapy to insure drying of the wound; restoration of the body surface by skin grafting, hastened by débridement agents, homografts and postmortem grafts; and prevention and correction of contractural deformities by the use of early skin grafts, thereby minimizing scarring and subsequent contractures.

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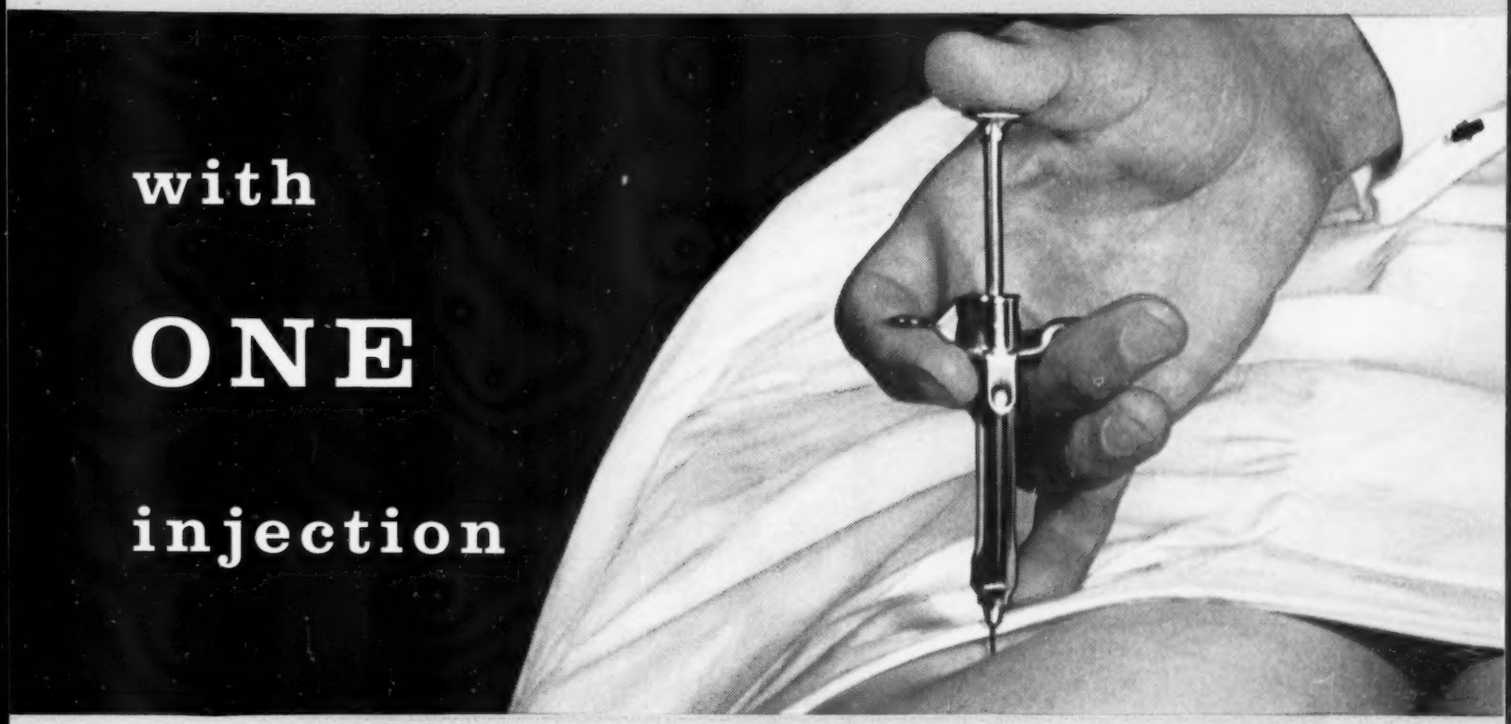

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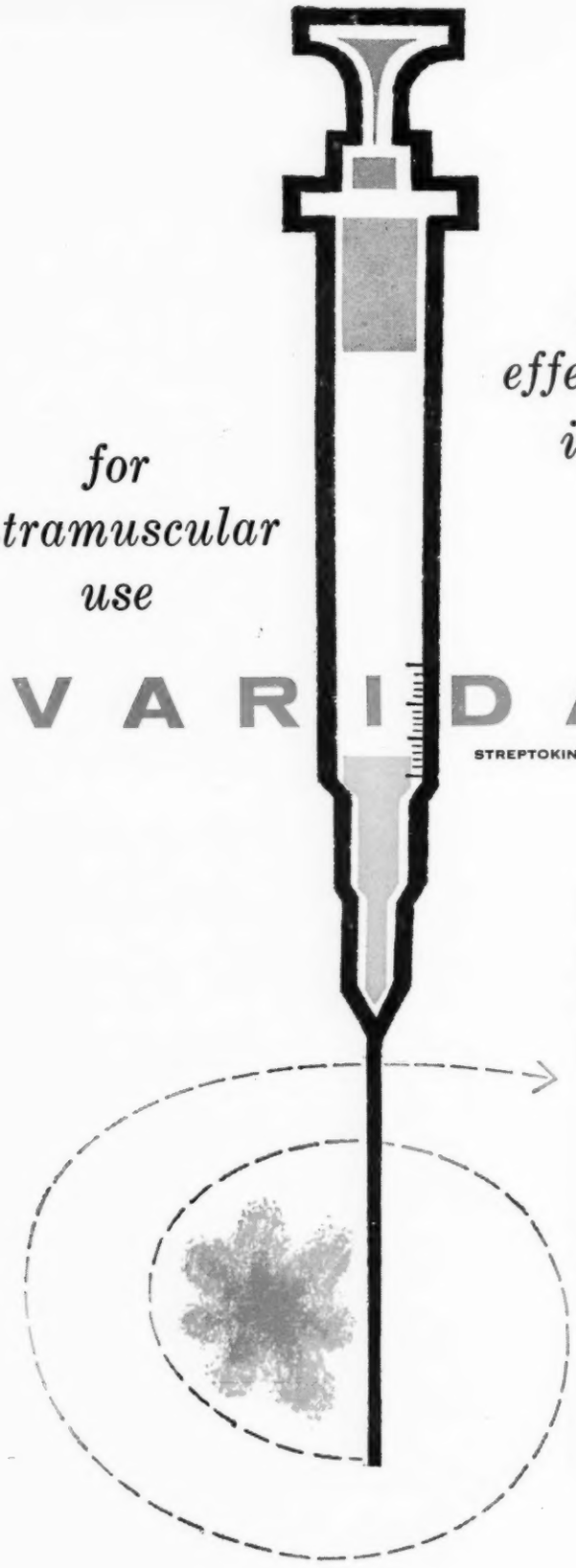

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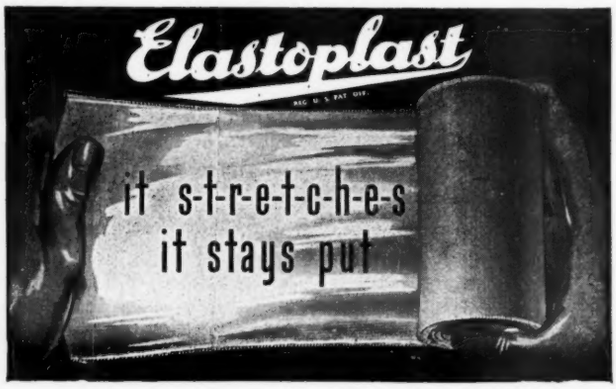

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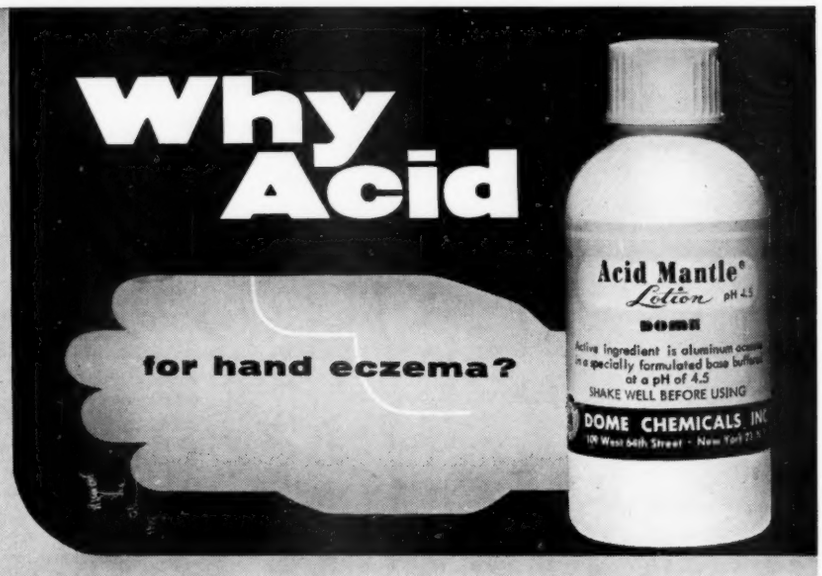

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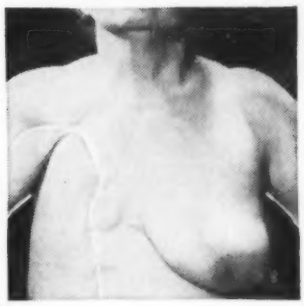

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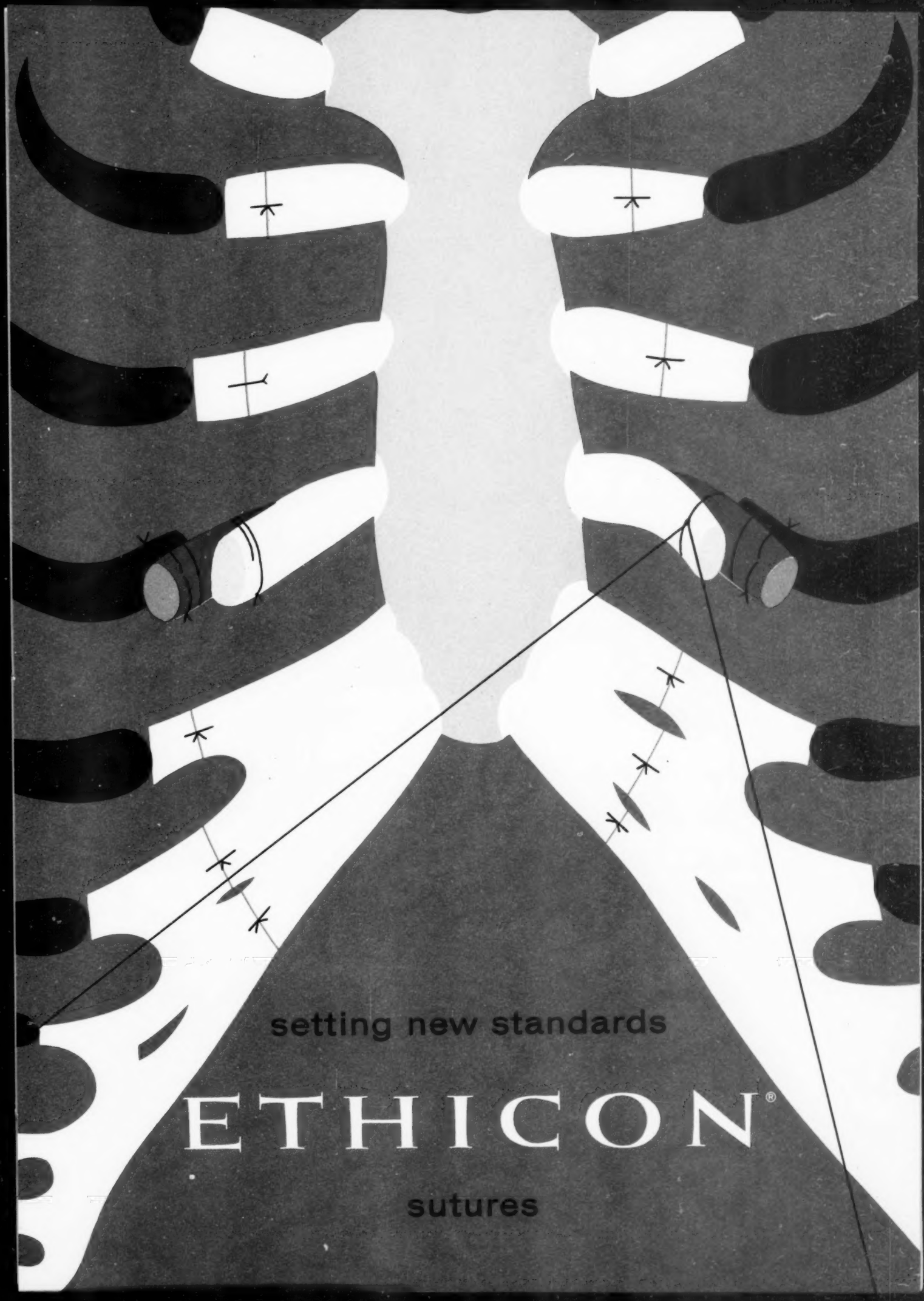
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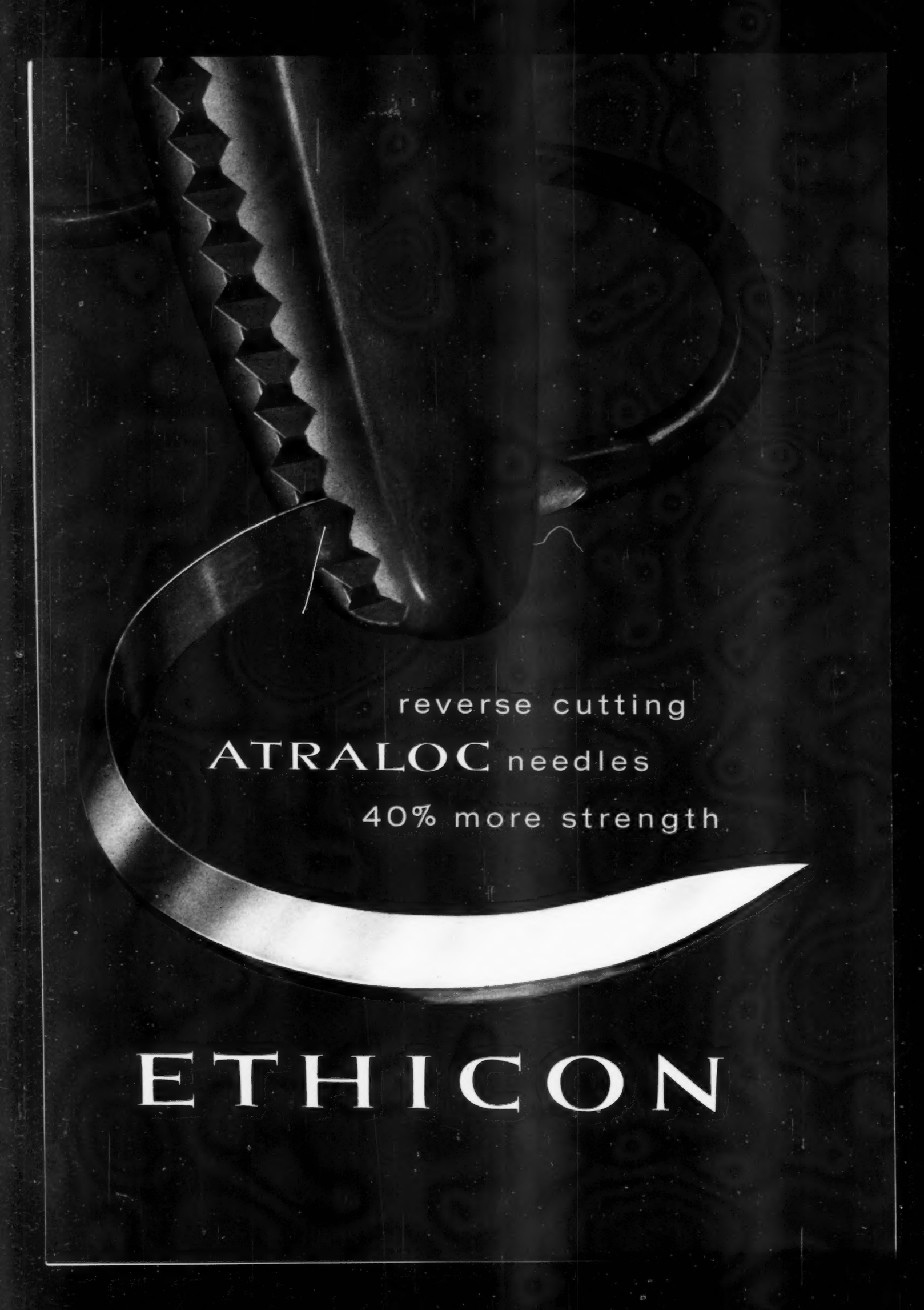
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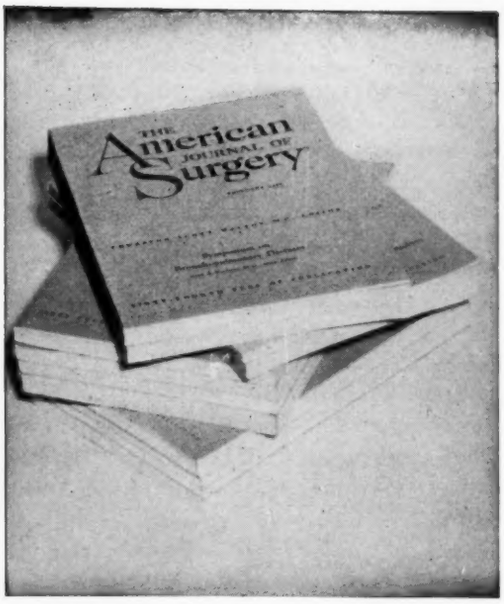

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1 heaping tbsp. GEVRAL PROTEIN
½ can condensed soup
¾ cup water

Put GEVRAL PROTEIN in saucepan. Add *small* amount of water to make smooth paste. Stir in remaining water, then slowly add condensed soup —chicken, asparagus, celery, or cream of mushroom.

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NOTES AND QUOTES

APPLICATIONS for certification (American Board of Obstetrics and Gynecology) for the 1957 Part 1 examinations are now being accepted. Candidates are urged to make such application at the earliest possible date. The deadline date for receipt of applications is October 1, 1956.

All candidates for admission to the examinations are required to submit with their application, a plain typewritten list of all patients admitted to the hospitals where they practice, for the year preceding their application or the year prior to their request for reopening of their application.

Application for re-examination, as well as requests for resubmission of case abstracts, must be made to the Secretary prior to October 1, 1956.

Current bulletins outlining present requirements may be obtained by writing to Dr. Robert L. Faulkner, American Board of Obstetrics and Gynecology, 2105 Adelbert Road, Cleveland 6, Ohio.

A medical research center will be constructed at Brookhaven National Laboratory. It is scheduled for completion in two years, at a cost of six million dollars exclusive of design and engineering. The new facility will house a nuclear reactor, a research hospital, an industrial medicine branch, and research divisions in medical physics, pathology, microbiology, biochemistry, physiology and clinical chemistry.

THE Surgical Division of Austenal Laboratories, Inc. announced its twentieth year of service to the medical profession.

During this time, vitallium® appliances have played an important part in the development of a relatively new surgical technic—human bone replacement. The first vitallium surgical screw was used in the repair of human bone in 1936 and as surgeons' faith grew, the first successful hip prosthesis was implanted in 1939. From 1936 to 1956 over six million vitallium appliances have been used and there has never been one authenticated case of corrosion reported.

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A simple new radioisotope test for intestinal disorders, which also aids in diagnosis of cancer of the pancreas, was described recently by a Duke University research team. The test involves a minute amount of radioactive iodine attached to a fatty substance which reveals whether fat in the diet is being properly digested.

Co-authors of the work are Dr. George J. Baylin, radiologist; Aaron P. Sanders, Director of the Duke radioisotope laboratory; Dr. William W. Shingleton, surgeon; and Dr. Julian M. Ruffin, internist.

Dr. Shingleton told members of the American Surgical Society that the test may point the way to further diagnostic tools and even new treatments for intestinal disorders, particularly for patients who remain underweight following operations for stomach ulcers.

In a series of eighty-nine such cases, almost two-thirds of the patients have remained underweight following operation. This may result from irregularities in digestion, he said.

Through the new test, the Duke team is conducting further studies on enzymes and other factors affecting digestion in order to learn more about such possibilities.

THE development of new pharmaceuticals such as the antibiotics, adrenal hormones and the Salk antipolio vaccine is given a prominent place in the newly published "New Worlds of Modern Science" anthology edited by Leonard Engel and released in April by Dell Publishing Co.

In the fifth section of his pocket-sized book, headed "Man," Mr. Engel has reprinted Berton Roueche's "Something Extraordinary" dealing with the discovery of terramycin® and originally published in *The New Yorker*, and Dr. Jonas Salk's "Studies in Human Subjects on Active Immunization against Poliomyelitis" which originally appeared in the *Journal of the American Medical Association*. An essay on the development of ACTH and cortisone and a synopsis of the famous Francis Report on the polio vaccine trials are also included.

Mr. Engel, whose articles appear regularly

CONTINUED ON PAGE 42

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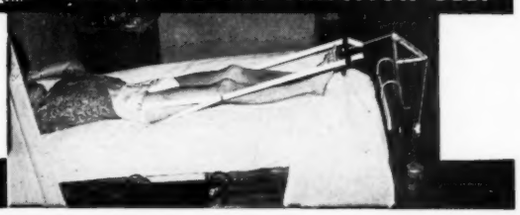
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NOTES AND QUOTES

both in *Harpers Magazine* and *The New York Times*, has put together a 380-page book dealing with a wide range of scientific subjects including Bertrand Russell's essay on space-time, William C. Menninger's "Psychoanalytic Psychiatry," and F. Macfarlane Burnet's "The Physical Nature of Viruses."

In introducing the chapters on terramycin and ACTH and cortisone, the author points out that succeeding developments in the antibacterial and steroid fields have brought a full dozen antibiotics into wide clinical use and have made both hydrocortisone and the more powerful prednisone and prednisolone available for general use. Mr. Engel also mentions the isolation of aldosterone by Reichstein and his co-workers.

Treatment of chronic intestinal amebiasis with milibis® (Winthrop Laboratories) was effective in 84.5 per cent of eighty-three ambulatory patients, according to Dr. Albert Milzer and associates (Antibiotic Medicine, 2: 42, 1956).

They add that side reactions observed during therapy with milibis (glycobiarsal) were minimal and did not interfere with treatment. Sixty-one of the eighty-three patients, or 73.5 per cent, showed no reactions. The remainder had reactions "of a mild degree," state Drs. Milzer, Edward Levy and Walter Sokniewicz.

The high cure rate obtained was "substantiated by the number of post-treatment examinations and long period of follow-up stool examinations," amounting to 547 days. Thirteen of the treated cases relapsed following a single course of milibis. Twelve of the thirteen responded to a second course and remained negative for 332 days in follow-up stool tests.

The authors note that milibis effectively cleared Iodamoeba williamsi, Endamoeba coli and Endolimax nana infections.

APPLICATIONS by research investigators for support of studies in or related to the cardiovascular field are now being accepted by the American Heart Association. The awards would be for the fiscal year beginning July 1, 1957. Application deadline for research fellowships and established investigatorships is September 15, 1956. For grants-in-aid, applications must be made by November 1, 1956. Awards are made in the following categories:

Established Investigatorships: Awarded for periods up to five years, subject to annual review, in amounts ranging from $6,000 to $9,000 per annum, to scientists of proved ability who have developed in their careers to the point where they are independent investigators.

Research Fellowships: Awarded to young men and women with doctoral degrees for periods of one to two years to enable them to train as investigators under experienced supervision. Annual stipends range from $3,500 to $5,600.

Grants-in-Aid: Made to experienced investigators in varying amounts up to $10,000 to provide support for specified projects.

The Association also maintains another and unique form of research support, the Career Investigatorship. This is given to a limited number of scientists of unusual capacity and accomplishment to assure them of financial support throughout their productive lives. Career Investigators are selected on the initiative of the Heart Association Research Committee and not from applications.

Funds for the research support program are provided from public contributions made to the annual Heart Fund appeal. At least half of all monies received by the American Heart Association national office are allocated to research.

Further information and application forms are available from the Medical Director, American Heart Association, 44 East 23rd Street, New York 10, New York.

A whole new field of anesthesia was opened up with a report on a new drug, viadril, by a team of Duke University anesthesiologists. The new drug leaves most patients with virtually no recollection of having been asleep, Dr. C. Ronald Stephen, chief of Duke's anesthesiology division, told the Southern Society of Anesthesiologists.

Viadril is primarily a hypnotic drug which produces insensibility to pain by the depth of hypnosis it produces. In doing so, it also produces more muscle relaxation than most anesthetic drugs, and causes less postoperative illness such as nausea and vomiting, he said.

In some 131 cases, however, the Duke team found one major disadvantage: the drug tends to

CONTINUED ON PAGE 44

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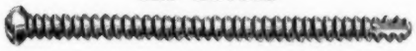

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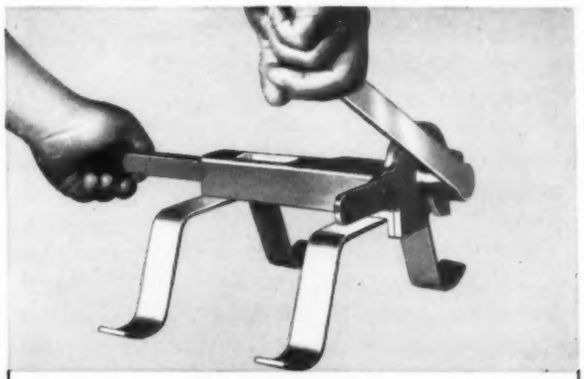

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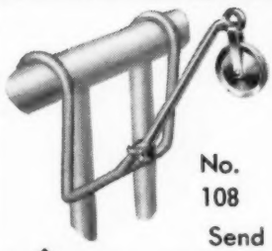

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produce irritation of the veins in many patients, Dr. Stephen pointed out.

"From the practical viewpoint, it seems doubtful at the moment that viadril is the answer to anesthetists' prayers, but it does open up an entirely new vista for exploration," he told the doctors.

Co-authors of the work with Dr. Stephen are Dr. Sara J. Dent, anesthesiologist, and Dr. W. P. Wilson, psychiatrist, both members of the Duke medical faculty and the Veterans Administration Hospital staff, Durham, N. C.

AWARDS of $830,000 to 131 scientists engaged in cardiovascular research for studies to be conducted during the twelve months beginning July 1, 1956, were announced recently by the American Heart Association.

According to Dr. Irvine H. Page, Association President, the awards raise to more than $14,000,000 the sums allocated by the Heart Association and its affiliates for scientific research in the field of the heart and blood vessel diseases since the organization became a national voluntary health agency in 1948. Later this year the Association will announce a group of awards in its "grant-in-aid" category, Dr. Page said.

Dr. Page pointed out that the national research program which the American Heart Association supports jointly with its state and local affiliates is financed through public contributions to the annual Heart Fund appeal. At least half the funds received from affiliated Heart Associations is allocated through the Association's National Office to support of research, according to Dr. Page, with the balance set aside to underwrite national activities in such fields as education and community services for heart patients. In addition, affiliated Heart Associations appropriate a sizable share of their income to support scientific investigations in their own areas.

The awards announced, said Dr. Page, provide for three Career Investigators, sixty-four Established Investigators and sixty-four Research Fellows, who will conduct their studies in twenty-four states, the District of Columbia, Great Britain, Greece and Denmark. The Career Investigatorship is a unique form of unrestricted lifetime support given to scientists of unusual accomplishment and outstanding ability. It provides $25,000 per year to cover the stipend of the Career Investigator and to help meet the expenses of his laboratory.

Two transparent plastic connecting tubes for suction apparatus are being introduced by Pharmaseal Laboratories, Glendale, California. One tube, the K-65, is 1½ feet long and is designed for connecting an aspirating bottle to a suction source. The other tube, the K-66, is 6 feet long. It serves as a connection between a suction catheter and an aspirating bottle. Both tubes are equipped with female plastic adapters on each end.

The manufacturer claims that these plastic connecting tubes are kink-resistant, lightweight, easier to clean and will not retain odors. They are not damaged by heat, oxidation or chemical action and give longer service than tubes made of other materials. Transparency permits clear observation of aspirate and facilitates locating and dislodging of obstructions.

RESEARCH grants totalling $30,000 have been made to six universities by the Lederle Laboratories Division, American Cyanamid Company, to study one of the major disease problems affecting the nation's four and a half billion dollar poultry industry. Known as "chronic respiratory disease," the disease is largely caused by organisms which resemble those responsible for pleuropneumonia.

New species of germs are being discovered in patients with pulmonary diseases. These microorganisms are not responsible for tuberculosis, but may cause similar types of disease that are being observed with increasing frequency, and some of them are resistant to tuberculosis drugs when first detected, according to papers given at the 52nd Annual Meeting of the National Tuberculosis Association.

The "new" germs which, like the tubercle bacillus that causes tuberculosis, are acid-fast, were discussed in papers presented at a medical session by Marie L. Koch, Ph.D., of the Veterans Administration Hospital, Wood, Wis., and Dr. Daniel S. Kusbner and Shirley McMillen of the Cook County Hospital, Chicago.

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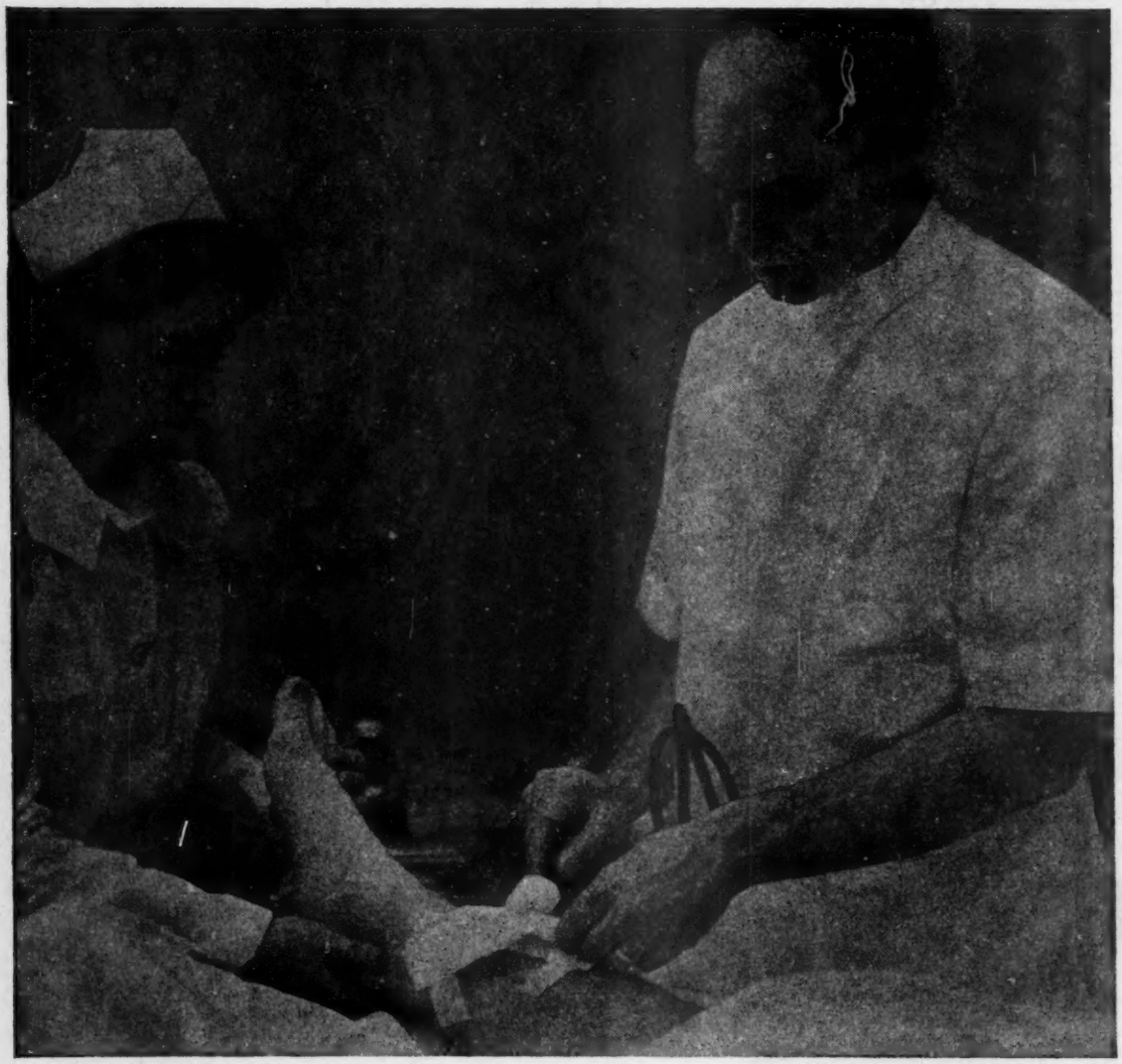

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